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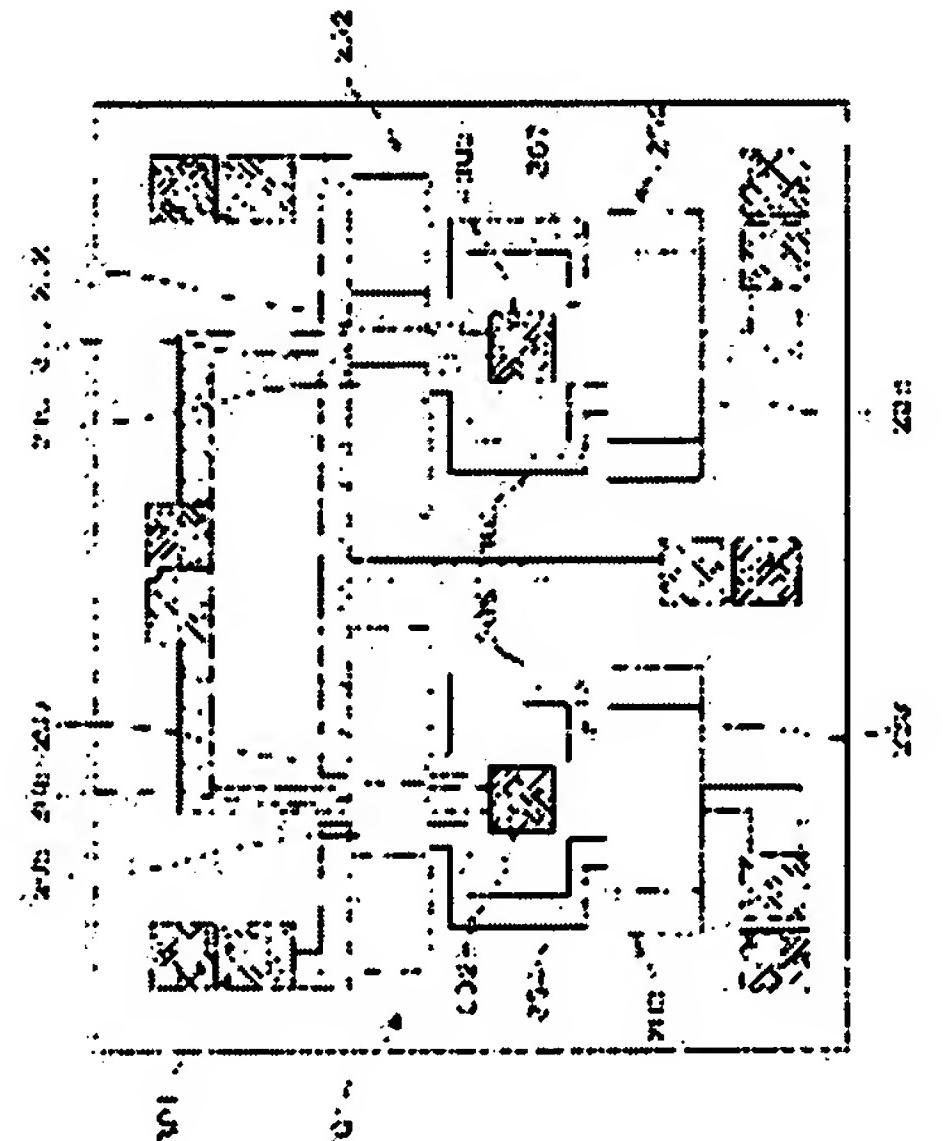
(22)Date of filing : 28.08.2002 (72)Inventor : TAKAMINE YUICHI

(54) SURFACE ACOUSTIC WAVE DEVICE AND COMMUNICATION EQUIPMENT

(57)Abstract:

PROBLEM TO BE SOLVED: To provide a surface acoustic wave device for improving the transmitting characteristics of a pass band.

SOLUTION: A transversely coupled resonator type surface acoustic wave filter 201 having at least three comb-shaped electrode parts 205, 206, and 207 is arranged on a piezoelectric substrate 301. At least one surface acoustic wave resonator 203 is arranged on the surface acoustic wave filter 201 so as to be serially connected to at least two comb-shaped electrode parts 205 and 207 of the surface acoustic wave filter 201. The value of a parasitic capacity inserted between the surface acoustic wave filter 201 and the surface acoustic wave resonator 203 is set so as to be $6.5 \times 10^2 / f_0 [\text{pF}]$ (in this case, f_0 is the central frequency [MHz] of the pass band of the surface acoustic wave filter 201).



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(54) 【発明の名称】 弹性表面波装置、通信装置

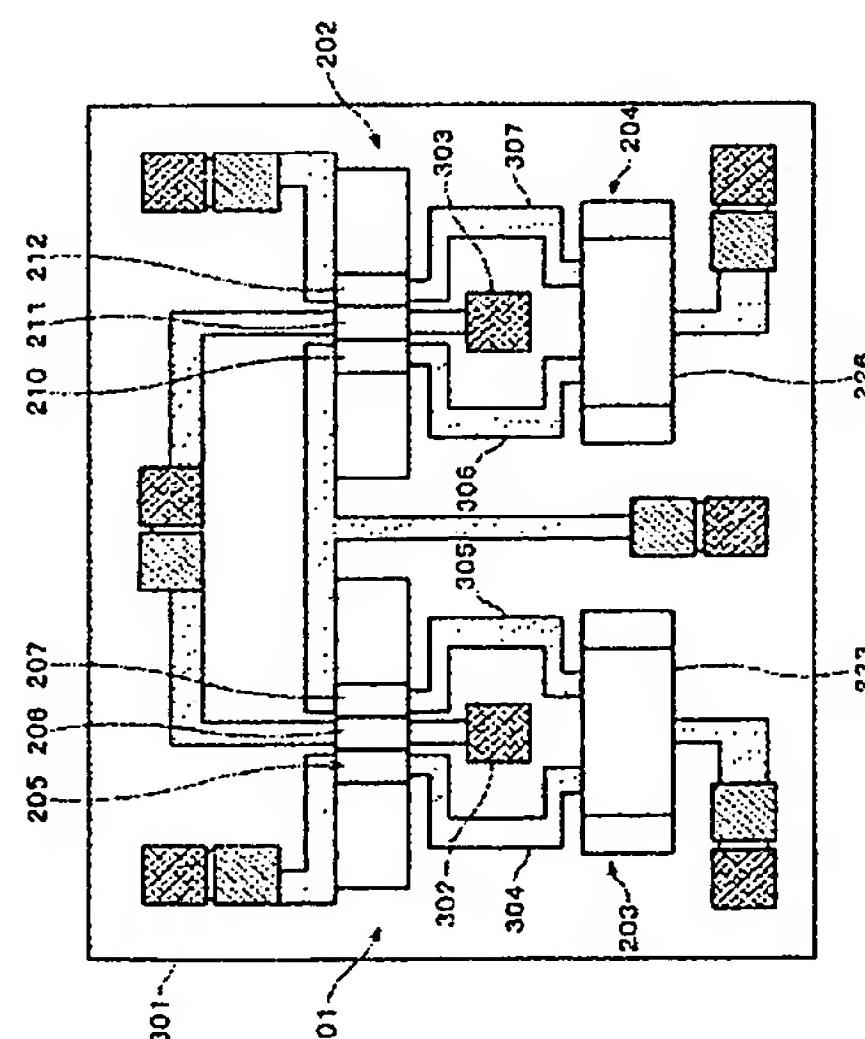
(57) 【要約】

【課題】特に通過帯域での伝送特性を改善できる弹性表面波装置を提供する。

【解決手段】少なくとも3つのくし型電極部205、206、207を有する、縦結合共振子型の弹性表面波フィルタ201を圧電基板301上に設ける。弹性表面波フィルタ201に少なくとも1つの弹性表面波共振子203を弹性表面波フィルタ201の少なくとも2つのくし型電極部205、207と直列接続させて設ける。弹性表面波フィルタ201と弹性表面波共振子203との間にに入る寄生容量の値を $6.5 \times 10^{-2} / f_0$ [pF]

(ただし、 f_0 は弹性表面波フィルタ201の通過帯域の中心周波数 [MHz])以下とする。

【選択図】 図1



【特許請求の範囲】**【請求項 1】**

圧電基板上に弾性表面波の伝搬方向に沿って形成された少なくとも3つのくし型電極部を有する縦結合共振子型弾性表面波フィルタと、該縦結合共振子型弾性表面波フィルタの少なくとも2つのくし型電極部に対して直列に接続された弾性表面波共振子とを有し、縦結合共振子型弾性表面波フィルタと弾性表面波共振子との間に入る寄生容量の値が、 $6.5 \times 10^{-2} / f_0$ [pF] (ただし、 f_0 は縦結合共振子型弾性表面波フィルタの通過帯域の中心周波数 [MHz]) 以下に設定されていることを特徴とする、弾性表面波装置。

【請求項 2】

圧電基板上に弾性表面波の伝搬方向に沿って形成された少なくとも3つのくし型電極部を有する縦結合共振子型弾性表面波フィルタと、該縦結合共振子型弾性表面波フィルタの少なくとも2つのくし型電極部に対して直列に接続された弾性表面波共振子とを有し、前記縦結合共振子型弾性表面波フィルタの少なくとも2つのくし型電極部と前記弾性表面波共振子とを直列接続する配線が、前記くし型電極部に接続されるアース側電極パッドを取り囲むように配置され、該アース側電極パッド以外の電極パッドに隣接して特性選別用パッドを有することを特徴とする、弾性表面波装置。

【請求項 3】

前記縦結合共振子型弾性表面波フィルタはリフレクタを有し、前記縦結合共振子型弾性表面波フィルタのくし型電極部のうち、前記弾性表面波共振子に接続されているくし型電極部および前記リフレクタと隣り合っているくし型電極部以外の全てのくし型電極部のアース端子が1つの電極パッドのみに接続されており、且つ、前記弾性表面波共振子に接続されているくし型電極部および前記リフレクタと隣り合っているくし型電極部以外のくし型電極部のアース側のくし型電極が、電極指によって共通化されていることを特徴とする、請求項1または2に記載の弾性表面波装置。

【請求項 4】

前記縦結合共振子型弾性表面波フィルタが、3つ若しくは5つのくし型電極部を有していることを特徴とする、請求項1ないし3の何れか1項に記載の弾性表面波装置。

【請求項 5】

前記縦結合共振子型弾性表面波フィルタにおける、前記弾性表面波共振子に接続されているくし型電極部のシグナル側のくし型電極と、該前記弾性表面波共振子に接続されているくし型電極部に隣接するくし型電極部のアース側のくし型電極とが互いに隣り合っている箇所において、くし型電極のバスバーを細くしたことを特徴とする、請求項1ないし4の何れか1項に記載の弾性表面波装置。

【請求項 6】

前記縦結合共振子型弾性表面波フィルタにおける、前記弾性表面波共振子が接続されている側に配置されているくし型電極部のアース端子に接続されている電極パッド、くし型電極部のアース端子と電極パッドを接続しているアースライン、および前記縦結合共振子型弾性表面波フィルタと前記弾性表面波共振子とを接続しているシグナルラインの少なくとも一つと圧電基板との間に絶縁層を設けたことを特徴とする、請求項1ないし5の何れか1項に記載の弾性表面波装置。

【請求項 7】

前記弾性表面波装置に、平衡-不平衡変換機能を持たせたことを特徴とする、請求項1ないし6の何れか1項に記載の弾性表面波装置。

【請求項 8】

前記圧電基板が、フェイスダウン工法でパッケージ内に収納されていることを特徴とする、請求項1ないし7の何れか1項に記載の弾性表面波装置。

【請求項 9】

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請求項 1 ないし 8 の何れか 1 項に記載の弹性表面波装置を有することを特徴とする通信装置。

【発明の詳細な説明】

【0001】

【発明の属する技術分野】

本発明は、伝送特性を改善できる弹性表面波装置およびそれを用いた通信装置に関するものである。

【0002】

【従来の技術】

近年の携帯電話機（通信装置）の技術的進歩は、目覚しいものがある。これを実現するために、携帯電話機のR F 段に使用する弹性表面波装置にも、高性能化が求められている。弹性表面波装置を高性能化する手法として、例えば特開平7-30367号公報に記載されているように、弹性表面波フィルタ、特に縦結合共振子型弹性表面波フィルタに対し、弹性表面波共振子を直列接続する構成が、広く用いられている。10

【0003】

図3に、この概略図を示す。図3の構成は、3つのくし型電極部（以下、IDTという）タイプの縦結合共振子型弹性表面波フィルタ101に対して直列に、弹性表面波共振子102が接続されている。その際、縦結合共振子型弹性表面波フィルタ101と弹性表面波共振子102の周波数関係は、弹性表面波共振子102の反共振周波数が縦結合共振子型弹性表面波フィルタ101の通過帯域より高周波側に、共振周波数が通過帯域内に位置するように設定されている。20

【0004】

これにより、弹性表面波共振子102の反共振周波数が縦結合共振子型弹性表面波フィルタ101の通過帯域より高周波側に位置しているので通過帯域高周波側ごく近傍の減衰量が大きくなり、かつ共振周波数が通過帯域内に位置しているので通過帯域内の挿入損失の大きな劣化は生じない。

【0005】

従来、弹性表面波装置の製造においては、製造工程において発生する不良品を除去するために、製品の完成段階以外に、ウェハ段階での特性選別を行うことがある。これにより、ウェハ段階で素子の不良品を除去しておくことで、不良品の素子までもパッケージに搭載してしまうことがなくなり、その結果、パッケージを無駄にすることがなくなり、コスト削減が可能となるためである。30

【0006】

このウェハ段階での特性選別を、針状のプローブを用いた測定にて行うために、専用の特性選別用パッド（以下、1測パッド）が設けられる。この1測パッドは、引き回しなどから発生する容量を低減するために、パッケージとの導通のための各電極パッドに隣接して設けることが多い。なお、1測パッドを別に設ける理由は、上記各電極パッドを用いてプローブによる測定を行った場合、上記各電極パッドがプローブの先端との当接により傷つき、パッケージとの接続に不具合を発生し易いためである。

【0007】

図3の構成の弹性表面波装置を実際に実現する場合の、圧電基板上のレイアウトの例を図4に示す。図4において、斜め格子にて示した四角がバンプボンド、またはワイヤボンド用の電極パッド、斜線の四角がウェハ状態でフィルタ特性を、プローブを用いて測定し選別するための1測パッドを示している。

【0008】

【発明が解決しようとする課題】

しかしながら、図3の構成では、弹性表面波共振子102を直列接続しない構成に比べて、通過帯域内の挿入損失が悪化するという問題があった。この原因を調査した結果、通過帯域内の挿入損失を悪化させている原因是、縦結合共振子型弹性表面波フィルタ101と弹性表面波共振子102との間にに入る（発生する）寄生容量が影響していることがわかつ40

た。

【0009】

すなわち、図4に示すように、弹性表面波共振子102を弹性表面波フィルタ101の少なくとも2つのIDTと直列接続する構造においては、それらを接続する配線である2本の各シグナルライン103、104が、電極パッド105、1測パッド106を囲むようなレイアウトになる。これにより、この2本のシグナルライン103、104と電極パッド105、1測パッド106との間で大きな寄生容量が発生し、この寄生容量が大きいことが、通過帯域内の挿入損失を悪化させている原因であることが分かった。

【0010】

本発明の目的は、図3のように、縦結合共振子型弹性表面波フィルタ101に対して弹性表面波共振子102を直列接続した構成において、寄生容量を低減できる圧電基板上のレイアウトを提案し、通過帯域内の挿入損失が良好な、弹性表面波装置を提供することにある。

【0011】

【課題を解決するための手段】

本発明の弹性表面波装置は、以上の課題を解決するために、圧電基板上に弹性表面波の伝搬方向に沿って形成された少なくとも3つのIDTを有する縦結合共振子型弹性表面波フィルタと、該縦結合共振子型弹性表面波フィルタの少なくとも2つのIDTに対して直列に接続された弹性表面波共振子とを有し、縦結合共振子型弹性表面波フィルタと弹性表面波共振子との間にに入る寄生容量の値が、 $6.5 \times 10^{-2} / f_0$ [pF] (ただし、 f_0 は縦結合共振子型弹性表面波フィルタの通過帯域の中心周波数 [MHz]) 以下に設定されていることを特徴としている。

【0012】

上記構成によれば、縦結合共振子型弹性表面波フィルタと弹性表面波共振子との間にに入る寄生容量の値を、 $6.5 \times 10^{-2} / f_0$ [pF] 以下に設定したので、上記寄生容量に起因する挿入損失の増加や、VSWRの劣化を抑制できて、通過帯域内の挿入損失が良好で、伝送特性に優れた弹性表面波装置を提供できる。

【0013】

本発明の他の弹性表面波装置は、以上の課題を解決するために、圧電基板上に弹性表面波の伝搬方向に沿って形成された少なくとも3つのIDTを有する縦結合共振子型弹性表面波フィルタと、該縦結合共振子型弹性表面波フィルタの少なくとも2つのIDTに対して直列に接続された弹性表面波共振子とを有し、前記縦結合共振子型弹性表面波フィルタの少なくとも2つのIDTと前記弹性表面波共振子とを直列接続する配線が、前記IDTに接続されるアース側電極パッドを取り囲むように配置され、該アース側電極パッド以外の電極パッドに隣接して接続される特性選別用パッドを有することを特徴としている。

【0014】

上記構成によれば、電極パッドに隣接して接続される特性選別用パッドを有するので、上記特性選別用パッドを介して、プローブにより弹性表面波装置の特性を検査し、その検査結果から上記弹性表面波装置を選別できる。

【0015】

また、上記構成では、特性選別用パッドが、前記縦結合共振子型弹性表面波フィルタの少なくとも2つのIDTと前記弹性表面波共振子とを直列接続する配線により取り囲まれる、前記IDTに接続されるアース側電極パッド以外の電極パッドに隣接して接続されているので、上記特性選別用パッドは、前記配線により取り囲まれる、前記IDTに接続されるアース側電極パッドに隣接することを回避できる。

【0016】

これにより、上記構成においては、特性選別用パッドがアース側電極パッドに隣接することに起因する寄生容量の増加を防止できて、上記寄生容量を、例えば $6.5 \times 10^{-2} / f_0$ [pF] 以下に設定できるので、上記寄生容量に起因する挿入損失の増加や、VSWRの劣化を抑制でき、通過帯域内の挿入損失が良好で、伝送特性に優れた弹性表面波装置を

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提供できる。

【0017】

上記弾性表面波装置では、前記縦結合共振子型弾性表面波フィルタはリフレクタを有し、前記縦結合共振子型弾性表面波フィルタのIDTのうち、前記弾性表面波共振子に接続されているIDTおよび前記リフレクタと隣り合っているIDT以外の全てのIDTのアース端子が1つの電極パッドのみに接続されており、且つ、前記弾性表面波共振子に接続されているIDTおよび前記リフレクタと隣り合っているIDT以外のIDTのアース側のくし型電極が、電極指によって共通化されていることが好ましい。

【0018】

上記構成によれば、弾性表面波共振子に接続されているIDTおよび前記リフレクタと隣り合っているIDT以外のIDTのアース側のくし型電極が、電極指によって共通化されているから、前記特性選別用パッドが、前記配線により取り囲まれる前記IDTに接続されるアース側電極パッドに隣接することの回避を確実化できる。

【0019】

これにより、上記構成においては、特性選別用パッドがアース側電極パッドに隣接することに起因する寄生容量の増加をより確実に防止できて、上記寄生容量を、例えば $6.5 \times 10^{-2} / f$ [pF] 以下に設定できるので、上記寄生容量に起因する挿入損失の増加や、VSWRの劣化を抑制でき、通過帯域内の挿入損失が良好で、伝送特性に優れた弾性表面波装置をより確実に提供できる。

【0020】

上記弾性表面波装置においては、前記縦結合共振子型弾性表面波フィルタが、3つ若しくは5つのIDTを有していることが望ましい。

【0021】

上記弾性表面波装置では、前記縦結合共振子型弾性表面波フィルタの前記弾性表面波共振子に接続されているIDTのシグナル側のくし型電極と、該前記弾性表面波共振子に接続されているIDTに隣接するIDTのアース側のくし型電極とが互いに隣り合っている箇所において、くし型電極のバスバーを他の箇所より細くしてもよい。

【0022】

上記構成によれば、互いに隣り合っている箇所において、くし型電極のバスバーを他の箇所より細くしたことにより、前記の寄生容量を低減でき、上記寄生容量に起因する挿入損失の増加や、VSWRの劣化を抑制でき、通過帯域内の挿入損失が良好で、伝送特性に優れた弾性表面波装置をより確実に提供できる。

【0023】

上記弾性表面波装置においては、前記縦結合共振子型弾性表面波フィルタにおける、前記弾性表面波共振子が接続されている側に配置されているくし型電極部のアース端子に接続されている電極パッド、くし型電極部のアース端子と電極パッドを接続しているアースライン、および前記縦結合共振子型弾性表面波フィルタと前記弾性表面波共振子とを接続しているシグナルラインの少なくとも一つと圧電基板との間に絶縁層を設けてもよい。

【0024】

上記構成によれば、電極パッド、アースライン、およびシグナルラインの少なくとも一つと圧電基板との間に、圧電基板より誘電率の小さい絶縁層を設けることで寄生容量値を減らすことができ、特性を改善できる。

【0025】

上記弾性表面波装置では、前記弾性表面波装置に、平衡-不平衡変換機能を持たせてもよい。上記弾性表面波装置においては、前記圧電基板が、フェイスダウン工法でパッケージ内に収納されていてもよい。

【0026】

本発明の通信装置は、前記の課題を解決するために、上記の何れかに記載の弾性表面波装置を有することを特徴としている。上記構成によれば、挿入損失が低減された、優れた伝送特性を備えた弾性表面波装置を有しているので、通信特性を向上できる

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【0027】**【発明の実施の形態】**

本発明の弾性表面波装置に係る各実施例について図1、図2、図5ないし図33に基づいて説明すれば、以下の通りである。

【0028】**(実施例1)**

図1、図2、および図5を用いて、本発明の実施例1の構成を説明する。なお、以後の各実施例では、DCS受信用フィルタ（通過帯域の中心周波数：1842.5MHz）を例にとって説明を行っていく。まず、図2を用いて、実施例1の電極構成について説明する。

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【0029】

実施例1では、図2に示すように、 $40 \pm 5^\circ$ Y cut X伝搬LiTaO₃からなる圧電基板301上に、各縦結合共振子型弾性表面波フィルタ201、202、および各縦結合共振子型弾性表面波フィルタ201、202に対してそれぞれ直列に接続された各弾性表面波共振子203、204が、アルミニウム（A1）電極により形成されている。

【0030】

各縦結合共振子型弾性表面波フィルタ201、202は、それらの弾性表面波の伝搬方向に沿って配置されていることが小型化を図れることから好ましい。各弾性表面波共振子203、204についても、それらの弾性表面波の伝搬方向に沿って配置されていることが小型化を図れることにより望ましい。実施例1の構成は、各縦結合共振子型弾性表面波フィルタ201、202を用いて平衡-不平衡変換機能を持たせた弾性表面波装置である。

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【0031】

縦結合共振子型弾性表面波フィルタ201の構成は、IDT（くし型電極部）206を弾性表面波の伝搬方向に沿って両側から挟み込むように各IDT205、207がそれぞれ形成され、さらに、それらの両側にリフレクタ208、209がそれぞれ形成されている。

【0032】

IDT205は、帯状の基端部（バスバー）と、その基端部の一方の側部から直交する方向に延びる複数の、互いに平行な電極指とを備えたくし型電極を2つ備えており、上記各くし型電極の電極指の側部を互いに対面するように互いの電極指間に組んだ状態にて上記各くし型電極を有するものである。

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【0033】

このようなIDT205では、各電極指の長さや幅、隣り合う各電極指の間隔、互いの電極指間での組んだ状態の対面長さを示す交叉幅を、それぞれ設定することにより信号変換特性や、通過帯域の設定が可能となっている。また、他の各IDTについても、IDT205と同様である。リフレクタは、伝搬してきた弾性表面波を伝搬してきた方向に反射する機能を有するものである。

【0034】

その上、図2を見るとわかるように、IDT205とIDT206との間、およびIDT206とIDT207との間における、数本の電極指のピッチを、IDTの他の部分よりも小さく設定している（図2の218、219の箇所）。

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【0035】

縦結合共振子型弾性表面波フィルタ202の構成は、基本的には縦結合共振子型弾性表面波フィルタ201と同じであるが、各IDT205、207に対して、各IDT210、212は、それらの位相が反転されている点が異なる。各IDT206、211は不平衡信号端子215、各IDT205、207、各IDT210、212はそれぞれ各弾性表面波共振子203、204を介して、それぞれ各平衡信号端子216、217に接続されている。

【0036】

弾性表面波共振子203の構成では、IDT223を弾性表面波の伝搬方向に沿って両側

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から挟み込むように各リフレクタ 222、224 がそれぞれ形成されている。弾性表面波共振子 204 の構成は、弾性表面波共振子 203 と全く同じ構成である。図 1 に、実施例 1 の構成の、実際の圧電基板 301 上でのレイアウトを示す。図 1において、図 2 に対応する箇所は同じ部材番号を用いて示している。図 1 では、斜め格子の四角がパッケージと導通を取るためのバンプボンド用電極パッド、斜線の四角が 1 測パッドである。

【0037】

実施例 1 の弾性表面波装置は、図 5 に示すように、圧電基板 301 の電極面とパッケージ 400 のダイアタッチ面 403 との間をバンプ 406 で導通を取り、圧電基板 301 での弾性表面波の発生を阻害しないように圧電基板 301 の電極面上に空間 405 を確保するフェイスダウン工法を用いて作製されている。パッケージ 400 は底板 401 と側壁部 402 とキャップ 404 とを有している。

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【0038】

実施例 1 の特徴は、図 1 において、IDT 205、207 と IDT 223、および IDT 210 と 212 と IDT 226 をそれぞれ接続している各引き回し 304、305、および各引き回し 306、307 の間にある各 IDT 206、211 のアース端子に、バンプボンド用の各電極パッド 302、303 のみがそれぞれ接続されて 1 測パッドが省かれており、かつ、上記の各電極パッド 302、303 以外の各電極パッドに隣接して 1 側パッドをそれぞれ設けたことである。

【0039】

上記の隣接とは、互いに近接して隣り合うことも含む。また、設ける 1 測パッドは、各 IDT のシグナル端子およびアース端子とそれらに対応する各電極パッドとを接続する引き回し上に設けられていることが、引き回しを必要以上に長くなることを回避できるから好ましい。

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【0040】

それに伴い、図 2 に示すように、IDT 206 のアース端子（アース側くし型電極）と各 IDT 205、207 のアース端子（アース側くし型電極）が 228、229 の箇所（互いに隣り合う箇所）において、IDT 211 のアース端子（アース側くし型電極）と各 IDT 210、212 のアース端子（アース側くし型電極）が 230、231 の箇所（互いに隣り合う箇所）において、電極指を用いて共通化、つまり互いに接続されている。

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【0041】

これにより、各 IDT 206、211 のアース端子に 1 測パッドをそれぞれ接続して設けなくても、各 IDT 205、207 の少なくとも何れかのアース端子、および各 IDT 210、212 の少なくとも何れかのアース端子に接続した 1 測パッドを介して、作製した弾性表面波装置のフィルタ特性をウェハ状態で確認して、ウェハ状態の上記各弾性表面波装置に関する特性選別をそれぞれ迅速に行うことができる。

【0042】

各縦結合共振子型弾性表面波フィルタ 201、202 の詳細な設計は、ピッチを小さくしていない電極指のピッチで決まる波長を λ_1 とすると、

交叉幅：4.1.8 λ_1

IDT 本数（205、206、207 の順）：18 (3) / (3) 33 (3) / (3) 1
8 本（カッコ内はピッチを小さくした電極指の本数）

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リフレクタ本数：60 本（201）、90 本（202）

duty：0.72 (IDT)、0.57 (リフレクタ)

電極膜厚：0.092 λ_1

弾性表面波共振子 403、404 の詳細な設計は、以下のとおりである。

交叉幅：3.4.9 λ_1

IDT 本数：250 本

リフレクタ本数：30 本

duty：0.60

電極膜厚：0.093 λ_1

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次に、本実施例1に係る弾性表面波装置の作用・効果について説明する。図6、図7に、実施例1の構成の周波数－伝送特性、および周波数－VSWR特性を示す。比較として図8、図9に示す、比較例1の構成の周波数－伝送特性、および周波数－VSWR特性も示す。

【0043】

比較例1の構成は、実施例1に記載の各IDT205～207のアース端子、各IDT210～212のアース端子をそれぞれ互いに分離した各IDT205a～207a、各IDT210a～212aを備えた各縦結合共振子型弾性表面波フィルタ201a、202aを用い、さらに、IDT206a、211aのアース端子に1測パッド501、502を設けている。それ以外の設計パラメータ等は、すべて同じである。

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【0044】

ちなみに、比較例1に比べて、実施例1では、縦結合共振子型弾性表面波フィルタ201と弾性表面波共振子203との間、縦結合共振子型弾性表面波フィルタ202と弾性表面波共振子204との間にに入る寄生容量が、約0.1pF小さい。図1、図2に示す実施例1の寄生容量の大きさは約0.30pFであり、比較例1（図8、図9）の寄生容量の大きさは約0.40pFであった。

【0045】

図6、図7を見ると、周波数－伝送特性、周波数－VSWR特性のどちらも実施例1の方が比較例1より良好であることがわかる。通過帯域内の挿入損失が良化した理由は、縦結合共振子型弾性表面波フィルタと弾性表面波共振子との間にに入る寄生容量が減ったために、特性インピーダンスからの不整合が小さくなつたことも一つの要因であるが、これ以外の別の損失要因も低減されることがわかった。

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【0046】

すなわち、図10に、実施例1と比較例1の周波数－伝送特性から、シミュレーションで不整合損を取り除いた（すべての周波数ポイントのインピーダンスを、特性インピーダンスと一致させた）場合の周波数－伝送特性を示す。

【0047】

図10を見ると、不整合損を取り除いても実施例1の方が挿入損失は小さい。つまり、縦結合共振子型弾性表面波フィルタと弾性表面波共振子との間にに入る寄生容量を減らすことは、不整合損だけではなく、不整合損以外の別の損失要因も低減する効果を有すると言える。

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【0048】

次に、具体的に縦結合共振子型弾性表面波フィルタと弾性表面波共振子との間の寄生容量を、どれだけにすればよいかを調査した。調査の方法は、縦結合共振子型弾性表面波フィルタと弾性表面波共振子との間の寄生容量をシミュレーションで0.15pF～0.45pFまで変化させ、DCS受信用フィルタとして必要な通過帯域幅75MHzを満足できる挿入損失の値を求めた。その結果を図33に示す。

【0049】

図33を見ると、縦結合共振子型弾性表面波フィルタと弾性表面波共振子との間の寄生容量の値が小さくなるほど、通過帯域幅75MHzを満足できる挿入損失が小さくなっていることがわかる。一般的にDCS受信用フィルタの挿入損失の市場要求は常温時で2dBであり、図33より、これを満足するためには縦結合共振子型弾性表面波フィルタと弾性表面波共振子との間の寄生容量の値を0.35pF以下にする必要があることがわかる。

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【0050】

つまり、中心周波数が1842.5MHzであるDCS受信用フィルタにおいては、0.35pFまでの寄生容量が、挿入損失が良好なフィルタを得るために、縦結合共振子型弾性表面波フィルタと弾性表面波共振子との間にあってよい許容範囲と言える。

【0051】

これにより、許容できる容量値が、 $1842.5 \times 0.35 = 6.5 \times 10^{-2}$ の値を中心周波数 [MHz] で割った値が、使用する中心周波数に対して、一般化して許容できる容

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量値の上限値となるので、許容できる寄生容量の範囲は、 $6.5 \times 10^{-2} / f_0$ [pF] (f_0 は縦結合共振子型弹性表面波フィルタの通過帯域の中心周波数 [MHz]) 以下と表すことができる。

【0052】

縦結合共振子型弹性表面波フィルタと弹性表面波共振子との間に入る寄生容量を減らす手段として、実施例1のように1測パッドの省略だけではなく、図2のようにIDT206、211のアース端子を電極指で他のIDTのアース端子と共にし、さらに、バンプボンド用の各電極パッド302、303も、図11のように省いた各縦結合共振子型弹性表面波フィルタ201b、202bを用いることも考えられる。この場合でも、各IDT206、211のアース端子が電極指を介して他のIDTのアース端子と共にとなっているので、ウェハ状態での特性選別は可能である。10

【0053】

しかし、図11の構成のように、バンプボンド用の電極パッド302、303をなくしてしまうと、各IDT206、211のアースが弱くなることでオーミック損が増加し、図12のように比較例1よりさらに挿入損失が悪化してしまう。つまり、最も良好な挿入損失を得るためにには、図1のように、各IDT206、211にはバンプボンド、もしくはワイヤボンド用の電極パッドをそれぞれ1つだけ接続することが望ましい。

【0054】

以上説明したように実施例1では、弹性表面波共振子を直列接続した2つの縦結合共振子型弹性表面波フィルタを用いて平衡-不平衡変換機能を持たせた弹性表面波装置において、縦結合共振子型弹性表面波フィルタと弹性表面波共振子との間の寄生容量を低減するために、中央IDTのアース端子の1測パッドをなくすることで、通過帯域内の挿入損失、およびVSWRを改善することができる。さらに中央IDTのアース端子を左右IDTのアース端子と共にすることで、中央IDTのアース端子の1測パッドがなくても、ウェハ状態で特性選別が可能である。20

【0055】

実施例1では平衡-不平衡変換機能を持たせた弹性表面波装置の例を示したが、図13のように平衡-不平衡変換機能を有さない弹性表面波装置においても、図14のように縦結合共振子型弹性表面波フィルタの中央IDTのアース端子に接続される1測パッドをなくすることで、縦結合共振子型弹性表面波フィルタと弹性表面波共振子との間の寄生容量が低減し、通過帯域内の挿入損失が改善した弹性表面波装置を得ることができる。30

【0056】

また、平衡-不平衡変換機能を持たせた弹性表面波装置の別の例としては、図15のように実施例1とは逆に、左右IDTを不平衡信号端子、中央IDTを平衡信号端子に接続する構成の弹性表面波装置においても、図16のように縦結合共振子型弹性表面波フィルタの中央IDTのアース端子に接続される1測パッドをなくすることで、縦結合共振子型弹性表面波フィルタと弹性表面波共振子との間の寄生容量が低減し、通過帯域内の挿入損失を改善した弹性表面波装置を得ることができる。

【0057】

また、図17のように、1つの縦結合共振子型弹性表面波フィルタを用い、その中央IDTを弹性表面波の伝搬方向に沿って2分割することで平衡-不平衡変換機能を有する構成の弹性表面波装置においても、図18のように縦結合共振子型弹性表面波フィルタの中央IDTのアース端子に接続される1測パッドをなくすることで、縦結合共振子型弹性表面波フィルタと弹性表面波共振子との間の寄生容量が低減し、通過帯域内の挿入損失を改善した弹性表面波装置を得ることができる。40

【0058】

また、実施例1では図5のように、バンプボンド法を用いるフェイスタウン工法にて、パッケージ400と圧電基板301上の各電極パッドとの導通を取る方法で弹性表面波装置を作製したが、これはワイヤボンド工法であっても問題はない。

【0059】

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また、フェイスダウン工法で作製する構成としては図5の構成に限らず、例えば図19のように集合基板1001上に圧電基板1002をフリップチップ工法で接合し、その上に樹脂1003を覆って封止して、ダイシングにより1パッケージ単位に切断する構成、図20のように同じく集合基板1101上に圧電基板1102をフリップチップ工法で接合し、その上にシート状の樹脂材1103を覆って封止して、ダイシングにより1パッケージ単位に切断する構成で、弾性表面波装置が作製されていてもよい。

【0060】

さらに、実施例1では、 $40 \pm 5^\circ$ Y cut X伝搬LiTaO₃からなる圧電基板301を用いたが、効果が得られる原理からもわかるとおり、本発明はこの圧電基板301に限らず、例えば $64^\circ \sim 72^\circ$ Y cut X伝搬LiNbO₃、 41° Y cut X伝搬LiNbO₃などの圧電基板でも同様な効果が得られる。10

【0061】

(実施例2)

図21、図22を用いて、本発明の実施例2の構成を説明する。まず、図21を用いて、実施例2の電極構成について説明する。実施例2では、 $40 \pm 5^\circ$ Y cut X伝搬LiTaO₃からなる圧電基板301上に、縦結合共振子型弾性表面波フィルタ1201および縦結合共振子型弾性表面波フィルタ1201と、それらに対して直列に接続された弾性表面波共振子1202が、A1電極により形成されている。

【0062】

縦結合共振子型弾性表面波フィルタ1201の構成においては、弾性表面波の伝搬方向に沿って配置された各IDT1203～1207を挟み込むように各リフレクタ1208、1209がそれぞれ形成されている。図21を見るとわかるように、2つのIDTが隣り合う箇所の電極指のピッチを、IDTの他の部分よりも小さくしている（図21の1210～1213の箇所）。

【0063】

各IDT1203、1205、1207は弾性表面波共振子1202を介して不平衡信号端子1214に、また、各IDT1204、1206はそれぞれ平衡信号端子1215、1216に接続されている。このとき、IDT1204に対してIDT1206が位相反転されており、これにより平衡－不平衡変換機能を持たせている。

【0064】

弾性表面波共振子1202の構成は、IDT1217を挟み込むように各リフレクタ1218、1219が形成されている。図22に、実施例2における、圧電基板301上の実際のレイアウトを示す。図22において、図21に対応する箇所は同じ部材番号を用いて示されている。20

【0065】

図22にて示すレイアウトでは、斜め格子状の四角がパッケージと導通を取るためのバンプボンド用電極パッド、斜線の四角が1測パッドである。実施例2の特徴は、図22において、各IDT1203、1205、1207とIDT1217とをそれぞれ接続している各引き回し1304、1305、1306の間に配置されている各IDT1204、1206のアース端子に、バンプボンド用電極パッド1302、1303のみがそれぞれ接続され、1測パッドがない、つまり省かれていることである。40

【0066】

それに伴い図21において、IDT1204のアース端子とIDT1203のアース端子が1220の箇所（互いに隣り合う箇所）において、IDT1206のアース端子とIDT1207のアース端子が1221の箇所（互いに隣り合う箇所）において、電極指を用いて共通化されている。これにより、各IDT1204、1206のアース端子に1測パッドを接続しなくても、ウェハ状態でフィルタ特性を確認して特性選別を行うことができる。

【0067】

縦結合共振子型弾性表面波フィルタ1201の詳細な設計は、ピッチを小さくしていない

電極指のピッチで決まる波長を λ I とすると、

交叉幅: 37.1λ I

I D T本数 (1, 203, 1204, 1205, 1206, 1207の順) : 22 (3)
 / (3) 31 (3) / (3) 37 (3) / (3) 31 (3) / (3) 22 本 (カッコ内は
 ピッチを小さくした電極指の本数)

リフレクタ本数: 60本

duty: 0.72 (I D T) , 0.57 (リフレクタ)

電極膜厚: 0.092λ I

弾性表面波共振子1202の詳細な設計は、以下のとおりである。

交叉幅: 50.7λ I

I D T本数: 250本

リフレクタ本数: 30本

duty: 0.60

電極膜厚: 0.093λ I

次に、本実施例2の構成に関する作用・効果について説明する。図23および図24に、実施例2の構成の周波数-伝送特性および周波数-VSWR特性をそれぞれ示す。比較として、図25および図26に、比較例2の構成を示す、また、比較例2の周波数-伝送特性および周波数-VSWR特性を図23および図24に合わせてそれぞれ示す。

【0068】

比較例2の構成は実施例2に対して、各I D T 1204, 1206のアース端子に1測パッドを設け、さらに各I D T 1203, 1204間の、各I D T 1206, 1207間のアース端子を互いに分離している。それ以外の設計パラメータ等は、すべて同じである。

【0069】

図23、図24を見ると、周波数-伝送特性、周波数-VSWR特性のどちらも実施例2の方が比較例2より良好であることがわかる。また、図27に、実施例2と比較例2の周波数-伝送特性から、シミュレーションで不整合損を取り除いた場合の周波数-伝送特性を示す。図27を見ると、実施例2のほうが、比較例2よりも挿入損失が小さいことがわかる。

【0070】

つまり実施例2のように5つのI D Tを用いた場合においても、実施例1と同様に縦結合共振子型弾性表面波フィルタと弾性表面波共振子との間の寄生容量を低減することで、不整合損だけではなく別の損失要因も低減され、通過帯域内の挿入損失が良好な弾性表面波装置が得られる。

【0071】

以上説明したように、実施例2では、弾性表面波共振子を直列接続した、5つのI D Tを有する縦結合共振子型弾性表面波フィルタを用いて平衡-不平衡変換機能を持たせた弾性表面波装置において、縦結合共振子型弾性表面波フィルタと弾性表面波共振子との間の寄生容量を低減することで、通過帯域内の挿入損失、およびVSWRを改善することができる。

【0072】

実施例2では、図21における各I D T 1204, 1206を平衡信号端子に接続して平衡-不平衡変換機能を有する例を示したが、例えば図28のように、中央に位置するI D T 1303を、弾性表面波の伝搬方向に沿って2分割して、各I D T 1301, 1303、1305を平衡信号端子に接続する構成においても、図29のようにI D T 1303のアース端子に接続される1測パッドをなくすることで、縦結合共振子型弾性表面波フィルタと弾性表面波共振子との間の寄生容量が低減し、通過帯域内の挿入損失が改善した弾性表面波装置を得ることができる。

【0073】

(実施例3)

図30に、本発明の実施例3を示す。実施例3では実施例1で示した構成に加えて、各I

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DT 205c、206c、207c、210c、211c、212cのバスバーにおいて、シグナル電極とアース電極とが互いに隣り合い、各縦結合共振子型弹性表面波フィルタ 201c、202cと各弹性表面波共振子 203、204との間に寄生容量が入る（発生する）箇所（図30では、1501～1504）において、バスバーを他の箇所より細くなるように設定している。

【0074】

言い換えると、各IDT 205c、206c、207c、210c、211c、212cのバスバーにおける、シグナル電極とアース電極とが互いに隣り合い、各弹性表面波共振子 203、204に近い側の各隅において、上記隣り合う間隔が、外方に向かって（弹性表面波の伝搬方向に対して直交する外向き）順次広くなるように設定されている。このとき、バスバーの細く設定した幅は、それに繋がる電極指の幅より大きいことが望ましい。また、その広がり方は、直線的でも曲線的でもよいが、強度の点や製造し易さから、曲線状に広げるほうが好ましい。

【0075】

次に、本実施例3の作用・効果について説明する。図30の構成においては、実施例1よりもさらに縦結合共振子型弹性表面波フィルタと弹性表面波共振子との間の寄生容量が低減され、さらに通過帯域内の挿入損失が改善された弹性表面波装置が得られる。

【0076】

（実施例4）

本発明の実施例4に係る弹性表面波装置では、図31に示すように、実施例1で示した構成に加えて、縦結合共振子型弹性表面波フィルタと弹性表面波共振子とを接続している各引き回し 304～307、およびパンプパッド用の各電極パッド 302、303と圧電基板 301との間で、縦結合共振子型弹性表面波フィルタ 201、202と弹性表面波共振子 203、204との間に挟まれた各領域に、圧電基板 301より比誘電率が小さい、各絶縁層 1401、1402がそれぞれ設けられている。

【0077】

つまり、本実施例4においては、弹性表面波共振子 203、204が接続されている側に配置されている、IDTのアース端子に接続されている電極パッド 302、303、IDTのアース端子と電極パッドを接続しているアースライン、および縦結合共振子型弹性表面波フィルタ 201、202と弹性表面波共振子 203、204とを接続している各シグナルライン 304～307の少なくとも一つと圧電基板 301との間に、上記各絶縁層 1401、1402が設けられている。

【0078】

図32に、前記各領域における一方の箇所の断面図を示す。圧電基板 301 上に絶縁層 1402が形成され、その絶縁層 1402 上に各引き回し 306、307や電極パッド 303が設けられている。各絶縁層 1401、1402としては、感光性ポリイミド等の感光性樹脂、SiO₂、SiN等が挙げられる。

【0079】

次に、本実施例4の作用・効果を説明する。図31のように、圧電基板 301 と各引き回し 304～307との間に各絶縁層 1401、1402を設けると、絶縁層 1401、1402は圧電基板 301 より比誘電率が小さいために、前述したコンデンサの容量値の式に基づき、縦結合共振子型弹性表面波フィルタ 201、202と弹性表面波共振子 203、204との間に入る寄生容量を低減することができる。これにより、本実施例4においては、前記の実施例1より、さらに通過帯域内の挿入損失を改善した弹性表面波装置が得られる。

【0080】

なお、上記の各実施例1ないし4では、それぞれの構成による作用・効果を説明したが、それら実施例1ないし4は、どのように組み合わせてもよい。

【0081】

（実施例5）

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次に、本発明に係る、上記実施例1ないし4の何れかに記載の弾性表面波装置を用いた通信装置について図34に基づき説明する。図34に示すように、上記通信装置600は、受信を行うレシーバ側(Rx側)として、アンテナ601、アンテナ共用部/RFTopフィルタ602、アンプ603、Rx段間フィルタ604、ミキサ605、1stIFフィルタ606、ミキサ607、2ndIFフィルタ608、1st+2ndローカルシンセサイザ611、TCXO(temperature compensated crystal oscillator(温度補償型水晶発振器))612、デバイダ613、ローカルフィルタ614を備えて構成されている。

【0082】

Rx段間フィルタ604からミキサ605へは、図34に二本線で示したように、バランス性を確保するために各平衡信号にて送信することが好ましい。10

【0083】

また、上記通信装置600は、送信を行うトランシーバ側(Tx側)として、上記アンテナ601および上記アンテナ共用部/RFTopフィルタ602を共用するとともに、TxIFフィルタ621、ミキサ622、Tx段間フィルタ623、アンプ624、カプラ625、アイソレータ626、APC(automatic power control(自動出力制御))627を備えて構成されている。

【0084】

そして、上記のRx段間フィルタ604、1stIFフィルタ606、TxIFフィルタ621、Tx段間フィルタ623、アンテナ共用部/RFTopフィルタ602には、上述した本実施例1ないし4の何れかに記載の、またはそれらの組み合わせた弾性表面波装置が好適に利用できる。20

【0085】

本発明に係る弾性表面波装置は、フィルタ機能と共に不平衡-平衡変換機能を備え、その上、挿入損失が小さいという優れた特性を有するものである。よって、上記弾性表面波装置を有する本発明の通信装置は、優れた伝送特性を有する上記弾性表面波装置を用いたことにより、小型化できると共に通信特性を向上できるものとなっている。

【0086】

【発明の効果】

以上説明したように、本発明は圧電基板上に弾性表面波の伝搬方向に沿って形成された少なくとも3つのIDTを有する縦結合共振子型弾性表面波フィルタと、前記縦結合共振子型弾性表面波フィルタに直列に接続されている少なくとも1つの弾性表面波共振子を有し、かつ前記弾性表面波共振子には、前記縦結合共振子型弾性表面波フィルタの複数のIDTのうち少なくとも2つのIDTが接続されている弾性表面波装置において、前記縦結合共振子型弾性表面波フィルタと弾性表面波共振子との間にに入る寄生容量の値を、 $6.5 \times 10^{-2} / f_0$ [pF] 以下(ただし f_0 は縦結合共振子型弾性表面波フィルタにおける通過帯域の中心周波数 [MHz])に設定した構成である。

【0087】

それゆえ、上記構成は、上記寄生容量の設定によって、帯域内挿入損失が改善し、かつVSWRが良好な弾性表面波装置を得ることができるという効果を奏する。40

【図面の簡単な説明】

【図1】本発明に係る、実施例1の弾性表面波装置における圧電基板上のレイアウトを示す概略平面図である。

【図2】上記実施例1の弾性表面波装置の構成図である。

【図3】従来の弾性表面波装置の構成図である。

【図4】上記従来の弾性表面波装置における圧電基板上のレイアウトを示す概略平面図である。

【図5】上記実施例1の弾性表面波装置の断面図である。

【図6】上記実施例1と比較例1との周波数-伝送特性をそれぞれ示すグラフである。

【図7】上記実施例1と比較例1との周波数-VSWR特性をそれぞれ示すグラフであり50

、(a)はS11のとき、(b)はS22のときである。

【図8】上記比較例1の弾性表面波装置の構成図である。

【図9】上記比較例1の圧電基板上のレイアウトを示す概略平面図である。

【図10】上記実施例1と比較例1との、不整合損を除去した場合の周波数ー伝送特性をそれぞれ示すグラフである。

【図11】上記実施例1から縦結合共振子型弾性表面波フィルタと弾性表面波共振子との間のバンプボンド用電極パッドを省いたときの、圧電基板上のレイアウトを示す概略平面図である。

【図12】図11と比較例1の周波数ー伝送特性をそれぞれ示すグラフである。

【図13】上記実施例1の弾性表面波装置における一変形例の構成図である。

【図14】上記図13に示す弾性表面波装置の、圧電基板上のレイアウトを示す概略平面図である。

【図15】上記実施例1の弾性表面波装置における他の変形例の構成図である。

【図16】上記図15に示す弾性表面波装置の、圧電基板上のレイアウトを示す概略平面図である。

【図17】上記実施例1の弾性表面波装置におけるさらに他の変形例の構成図である。

【図18】上記図17に示す弾性表面波装置の、圧電基板上のレイアウトを示す概略平面図である。

【図19】上記実施例1の弾性表面波装置の一製造プロセスを示す断面図である。

【図20】上記実施例1の弾性表面波装置の他の一製造プロセスを示す断面図である。

【図21】本発明に係る、実施例2の弾性表面波装置の構成図である。

【図22】上記実施例2の弾性表面波装置における、圧電基板上のレイアウトを示す概略平面図である。

【図23】上記実施例2と比較例2との周波数ー伝送特性をそれぞれ示すグラフである。

【図24】上記実施例2と比較例2との周波数ーVSWR特性をそれぞれ示すグラフであり、(a)はS11のとき、(b)はS22のときである。

【図25】上記比較例2の弾性表面波装置の構成図である。

【図26】上記比較例2の弾性表面波装置における、圧電基板上のレイアウトを示す概略平面図である。

【図27】上記実施例2と比較例2との、不整合損を除去した周波数ー伝送特性をそれぞれ示すグラフである。

【図28】上記実施例2の弾性表面波装置における、一変形例の構成図である。

【図29】上記図28に示す弾性表面波装置における、圧電基板上のレイアウトを示す概略平面図である。

【図30】本発明に係る、実施例3の弾性表面波装置の構成図である。

【図31】本発明に係る、実施例4の弾性表面波装置における概略平面図である。

【図32】上記実施例4の絶縁層を設けた箇所の断面図である。

【図33】本発明に係る弾性表面波装置における、寄生容量の規格値を示すためのグラフであって、本発明および比較例の各弾性表面波装置における寄生容量の変化に対する挿入損失の変化を示すグラフである。

【図34】本発明の弾性表面波装置を用いた通信装置の要部ブロック図である。

【符号の説明】

201 縦結合共振子型弾性表面波フィルタ

203 弹性表面波共振子

205、206、207 IDT (くし型電極部)

301 圧電基板

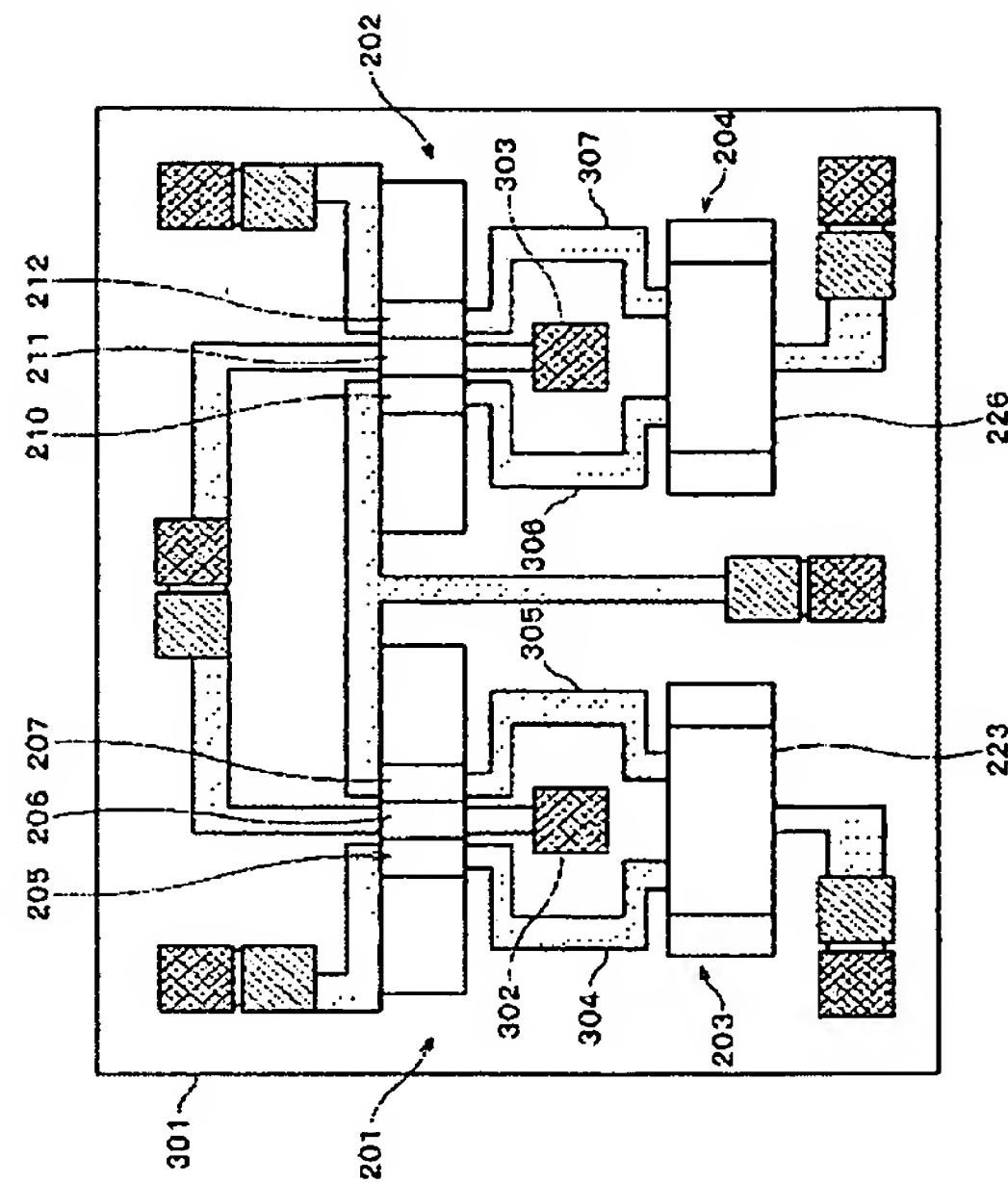
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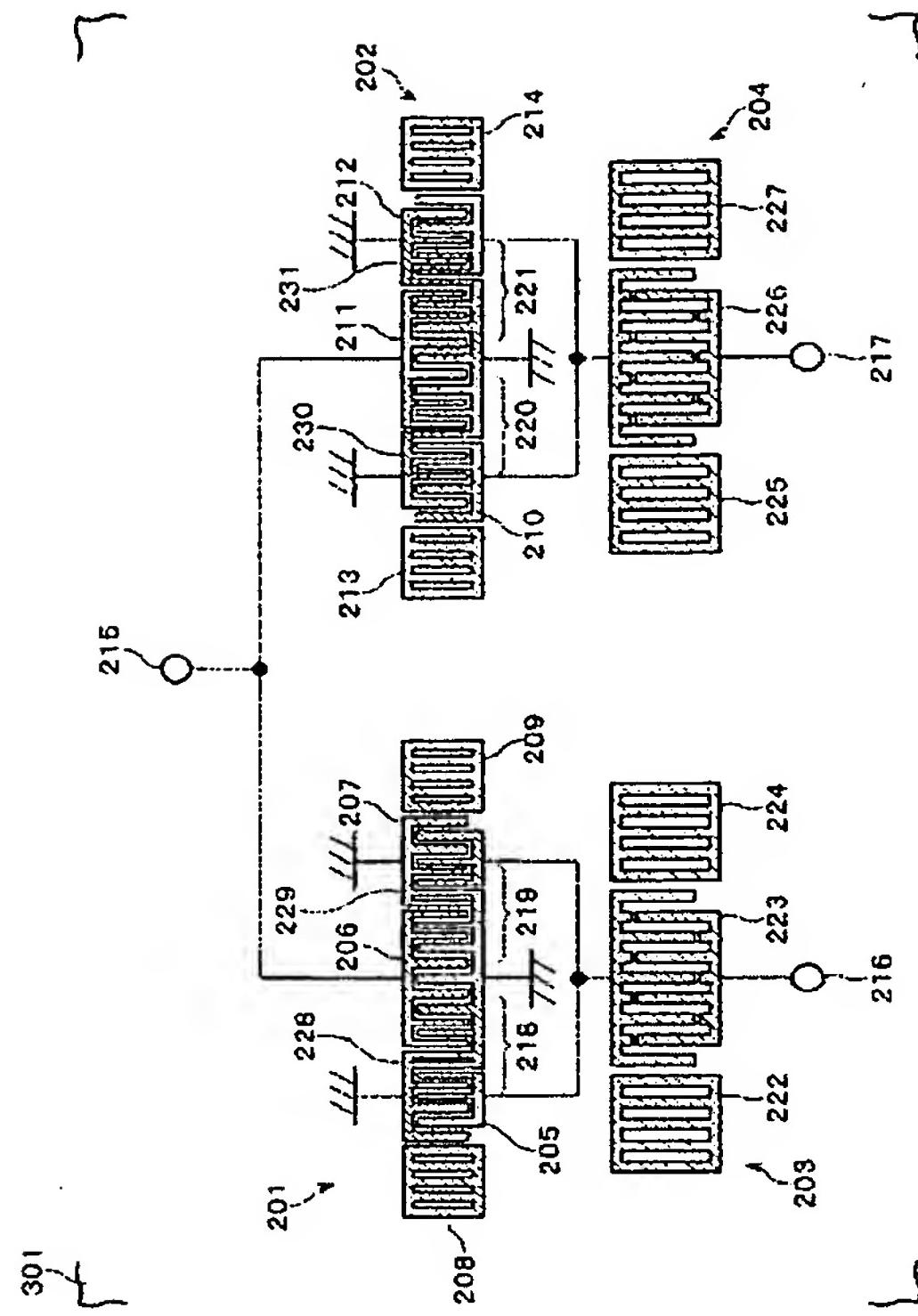
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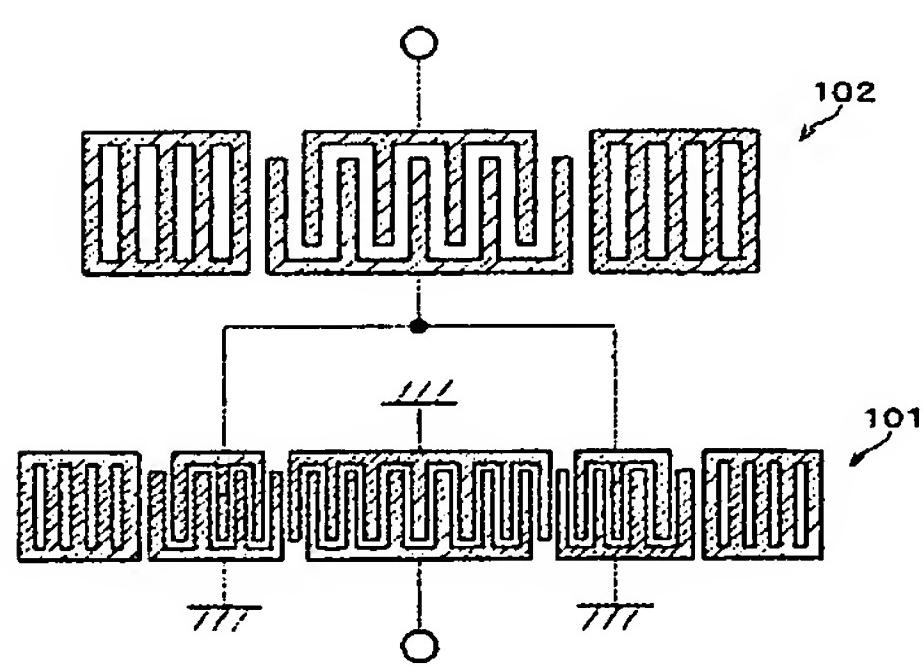
【四】



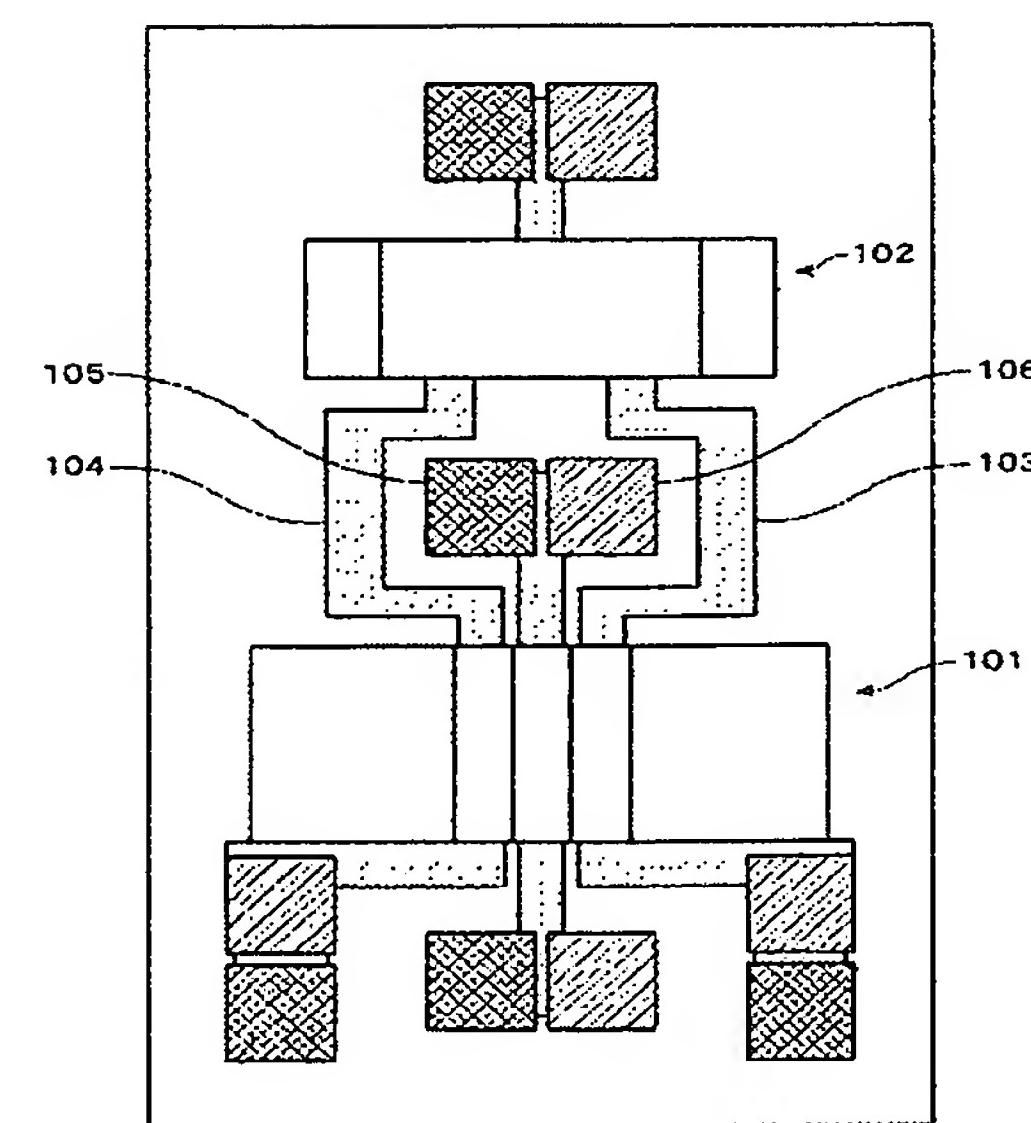
【 2】



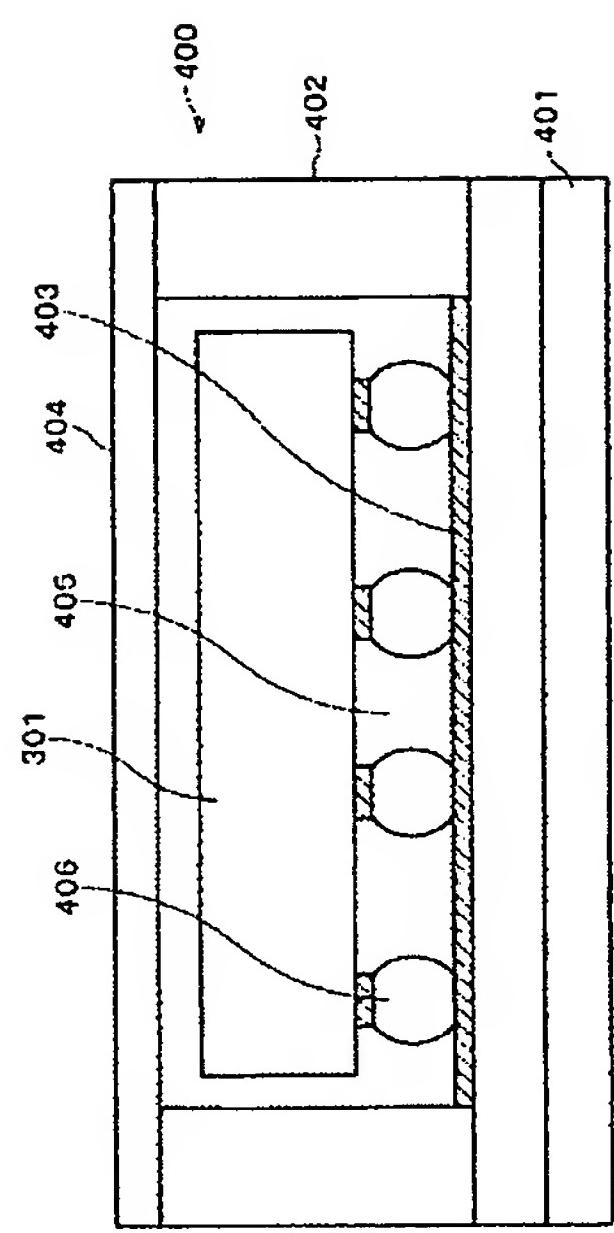
【図3】



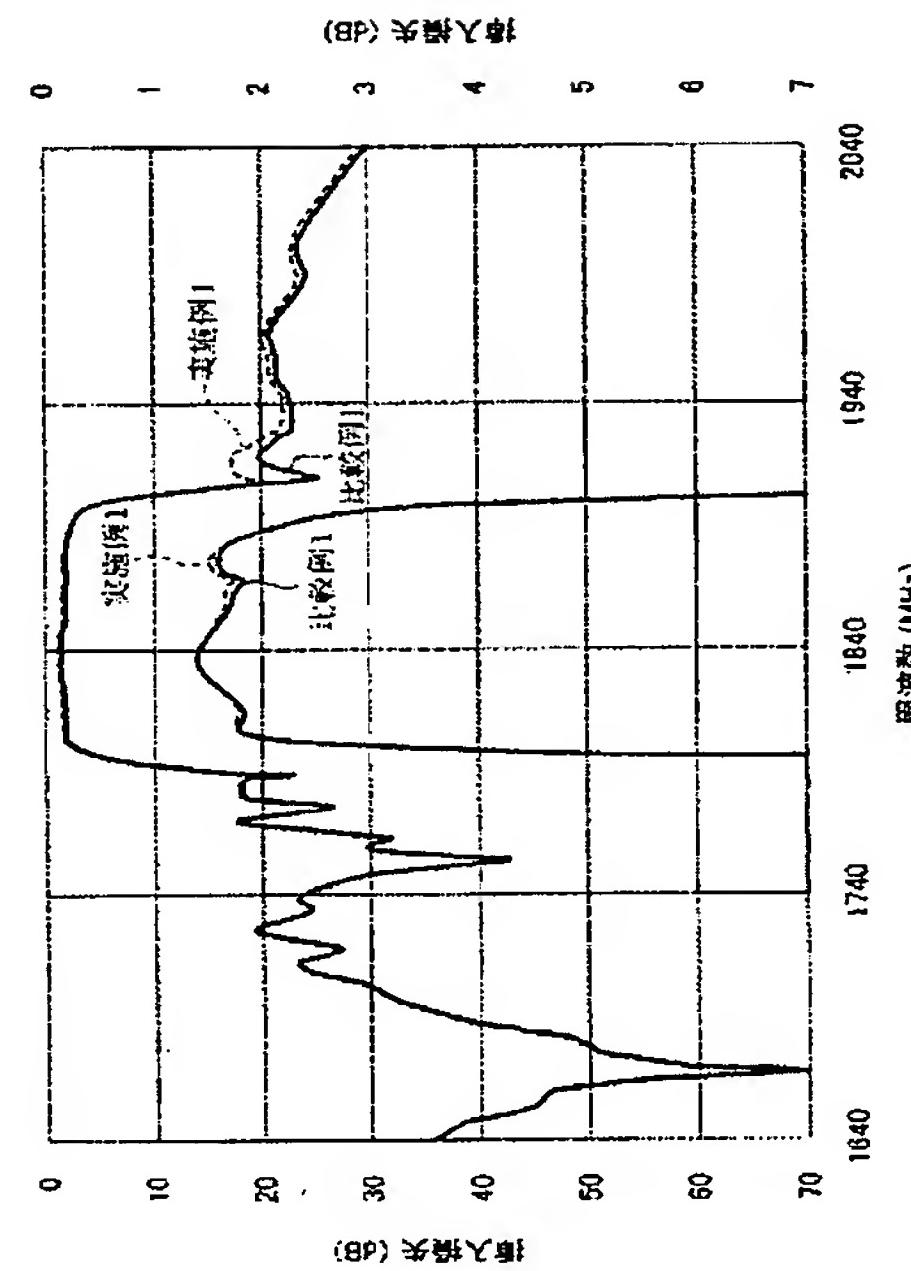
【四】



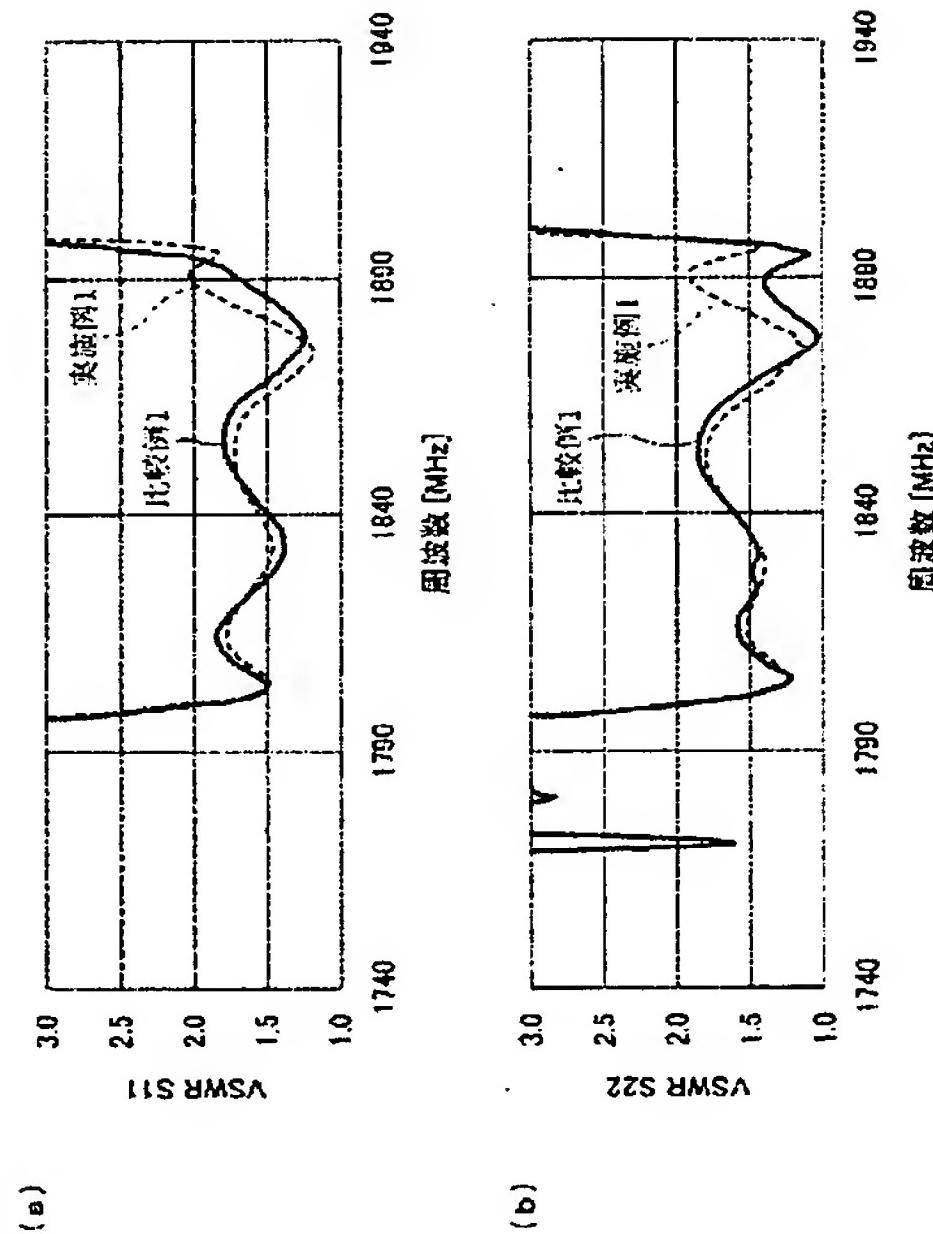
【図5】



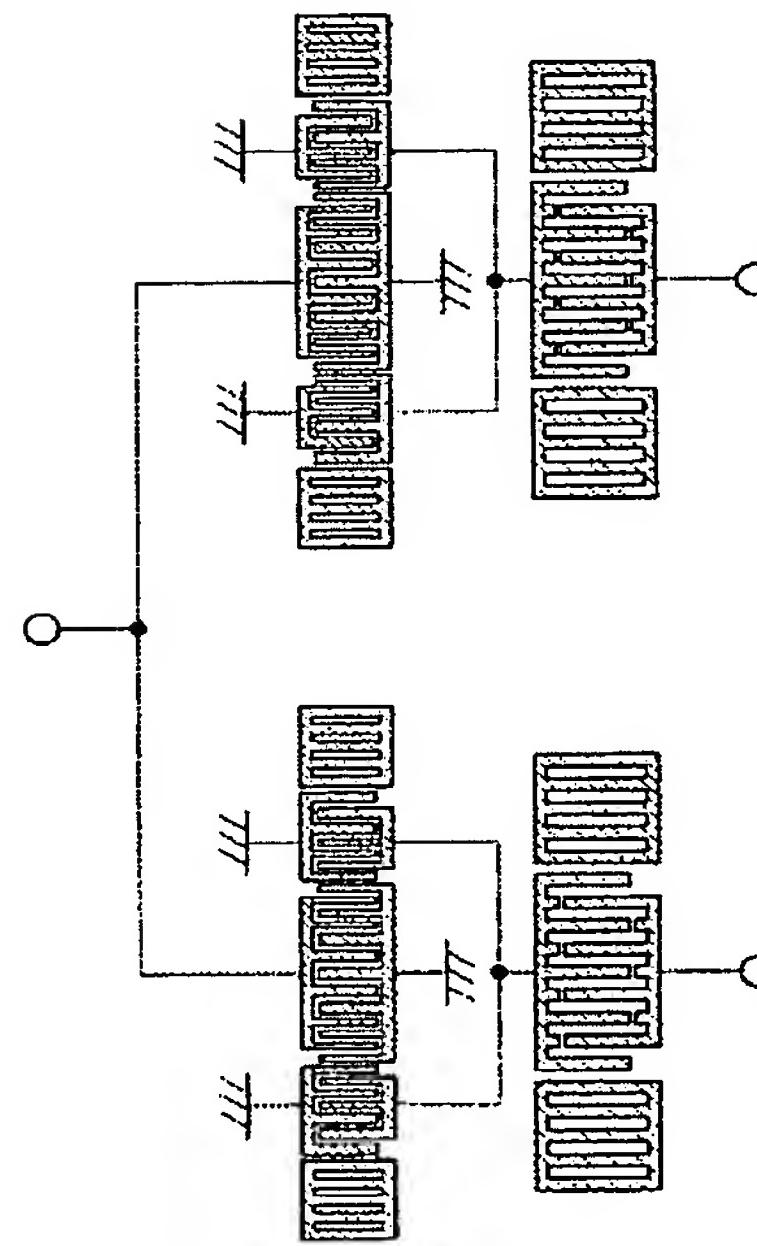
【図6】



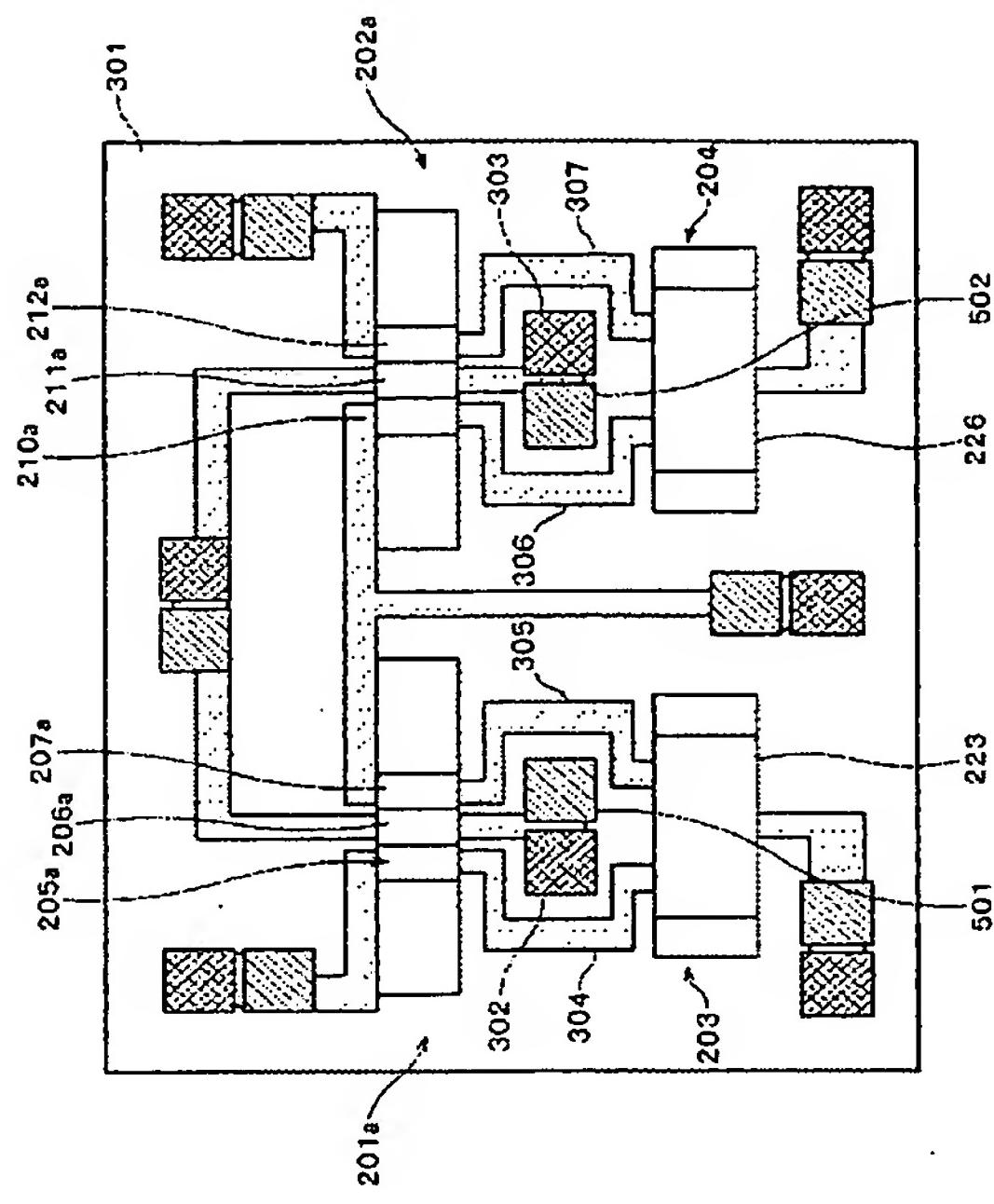
【図7】



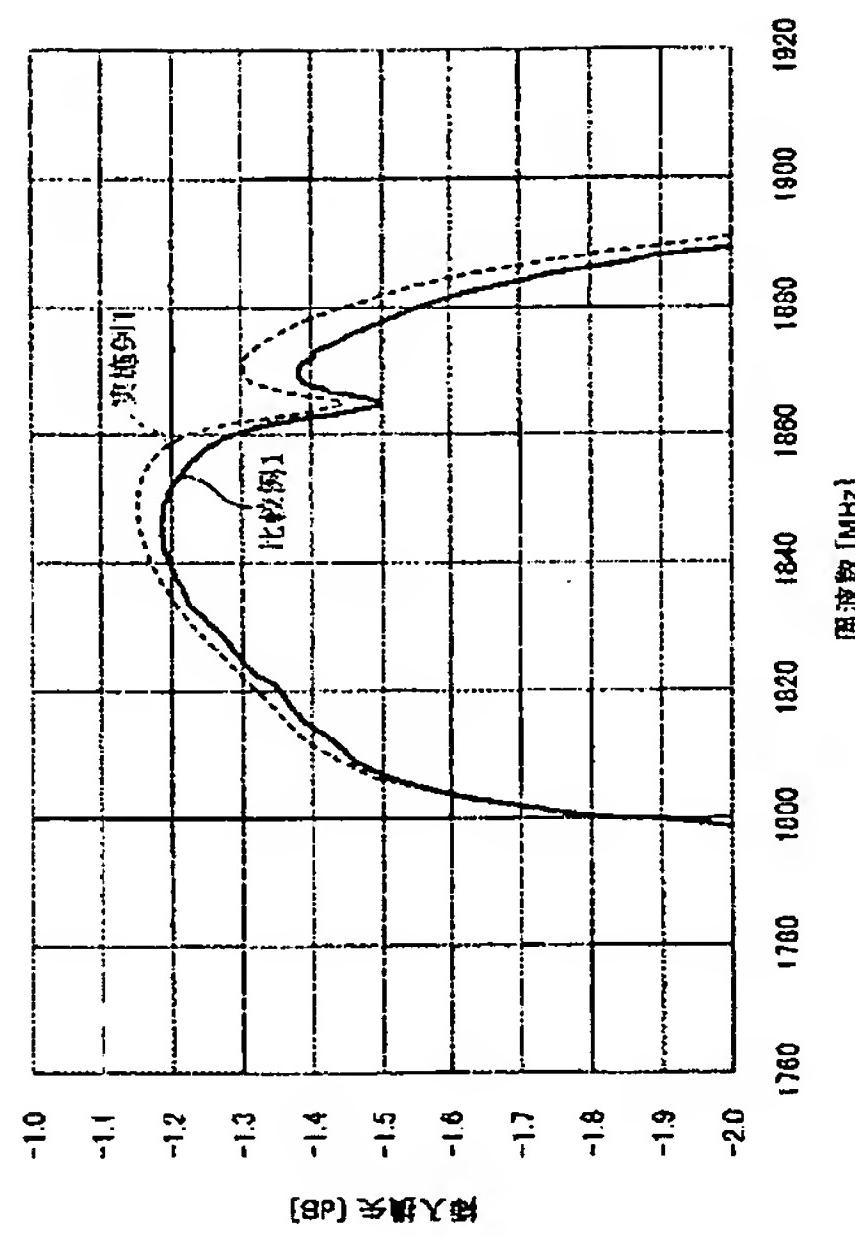
【図8】



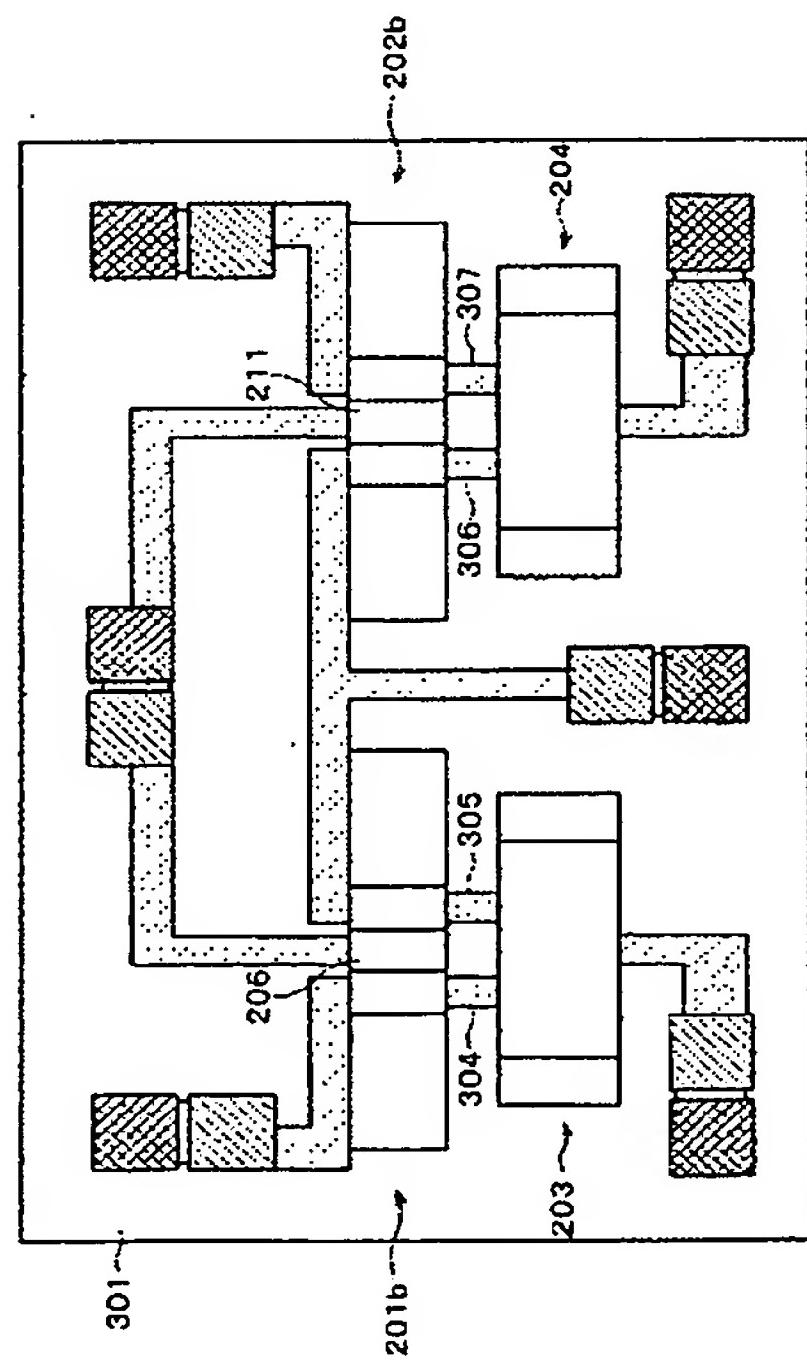
【図9】



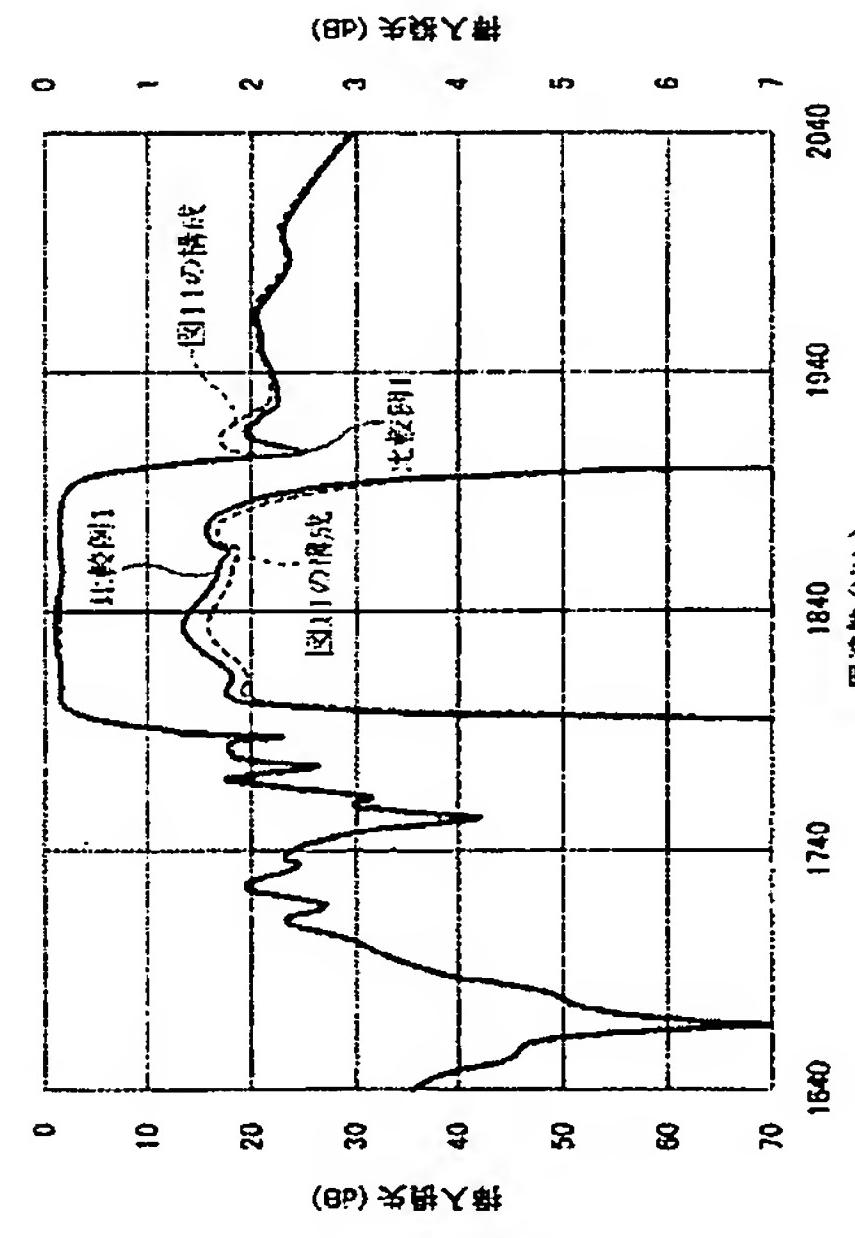
【図10】



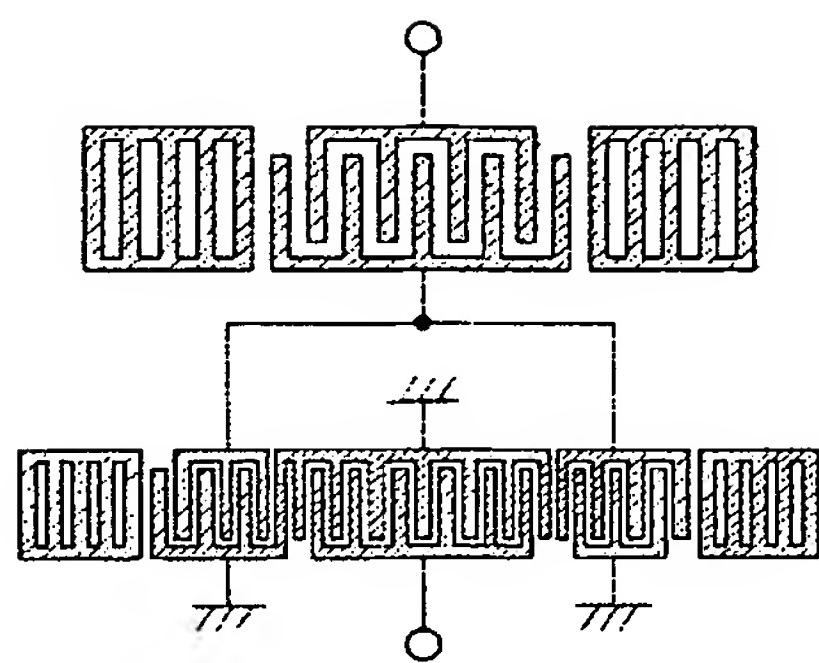
【図11】



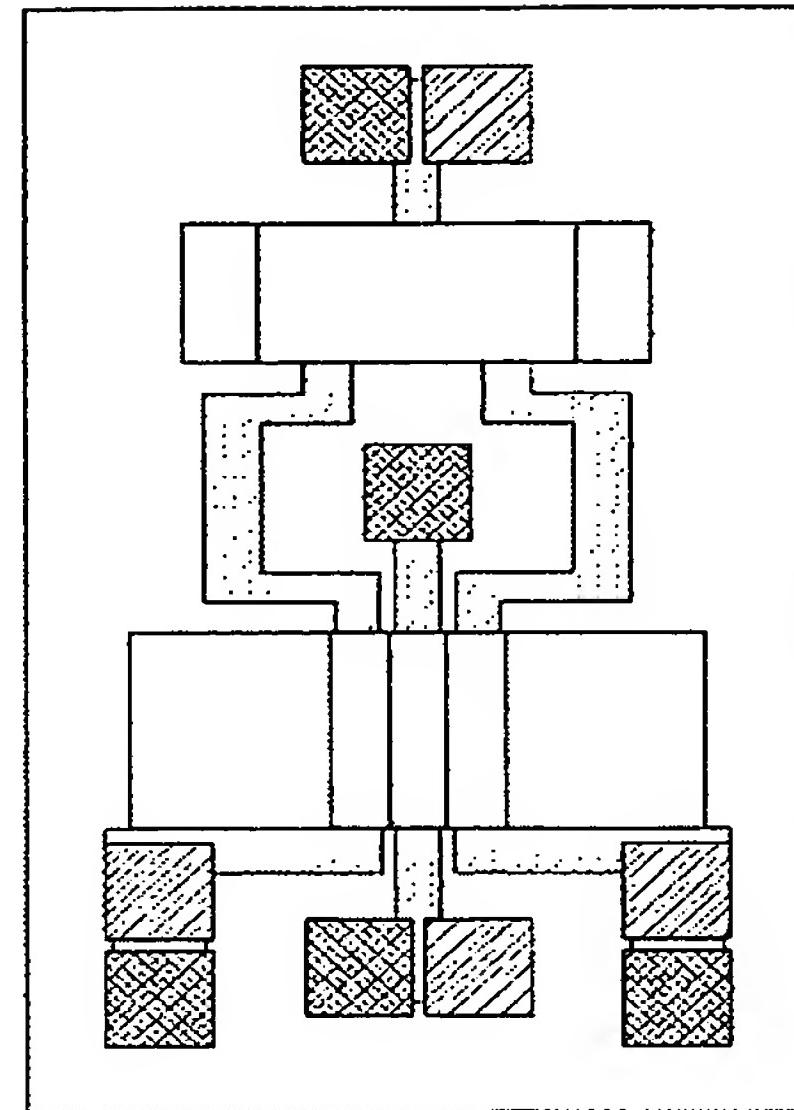
【図12】



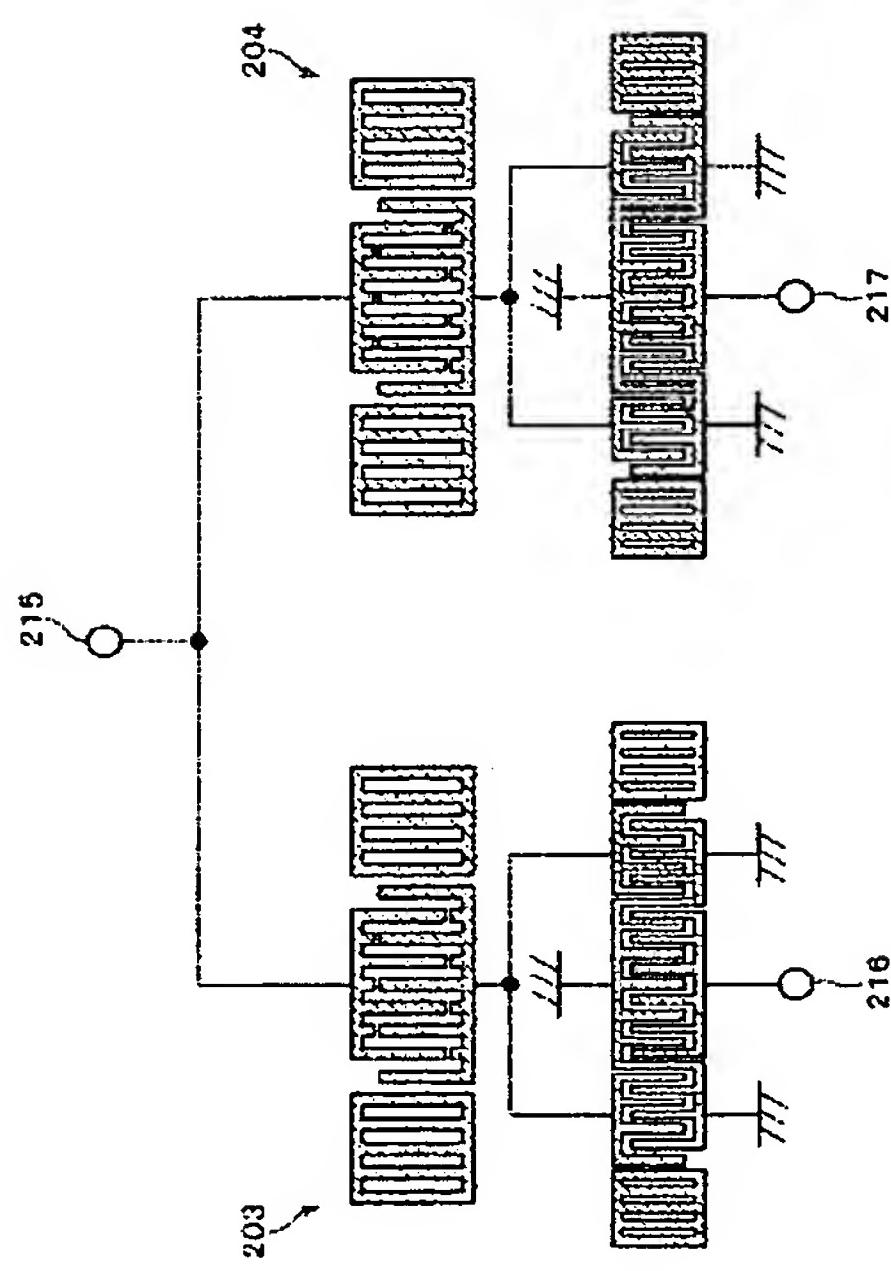
【図13】



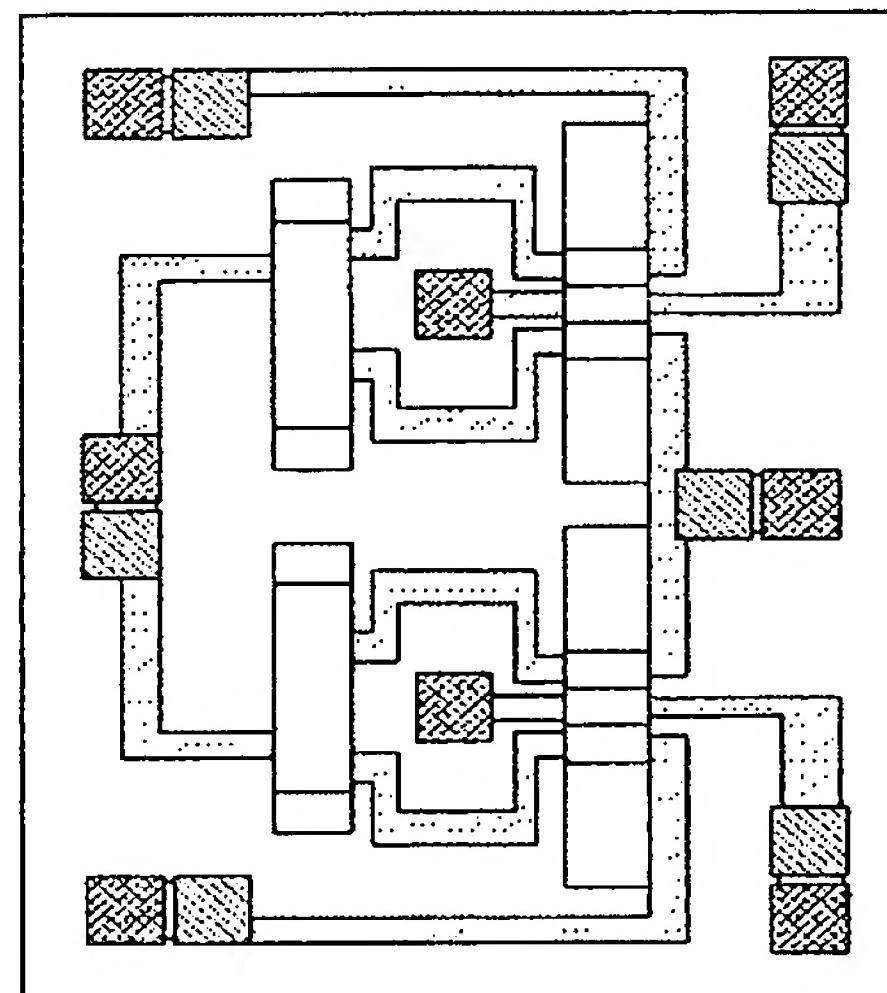
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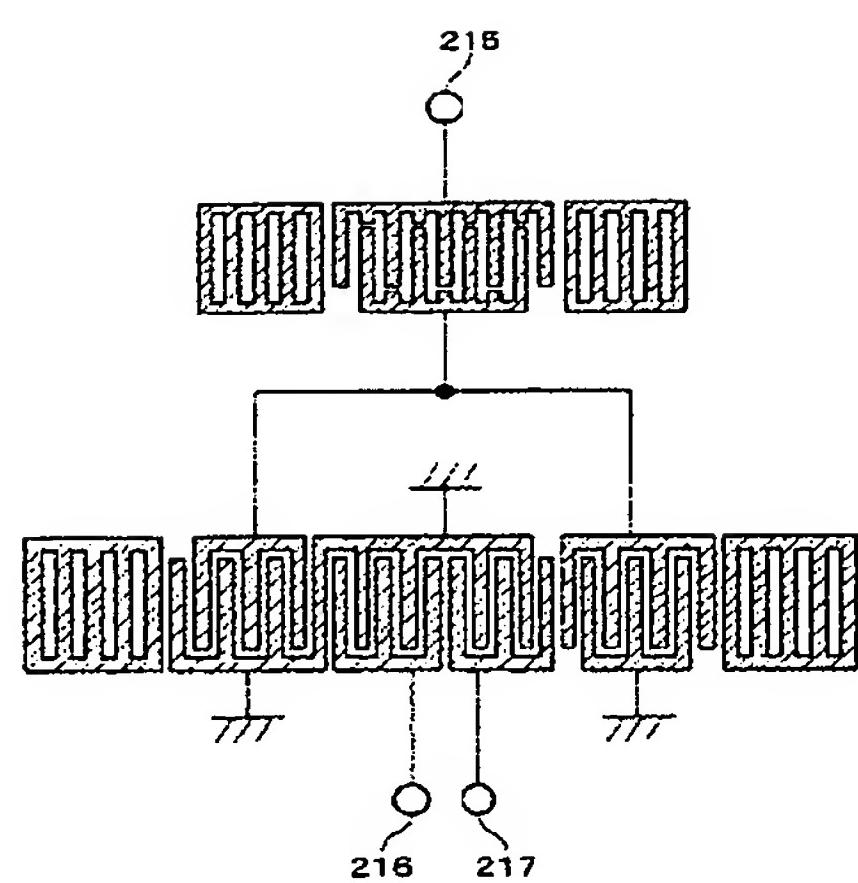
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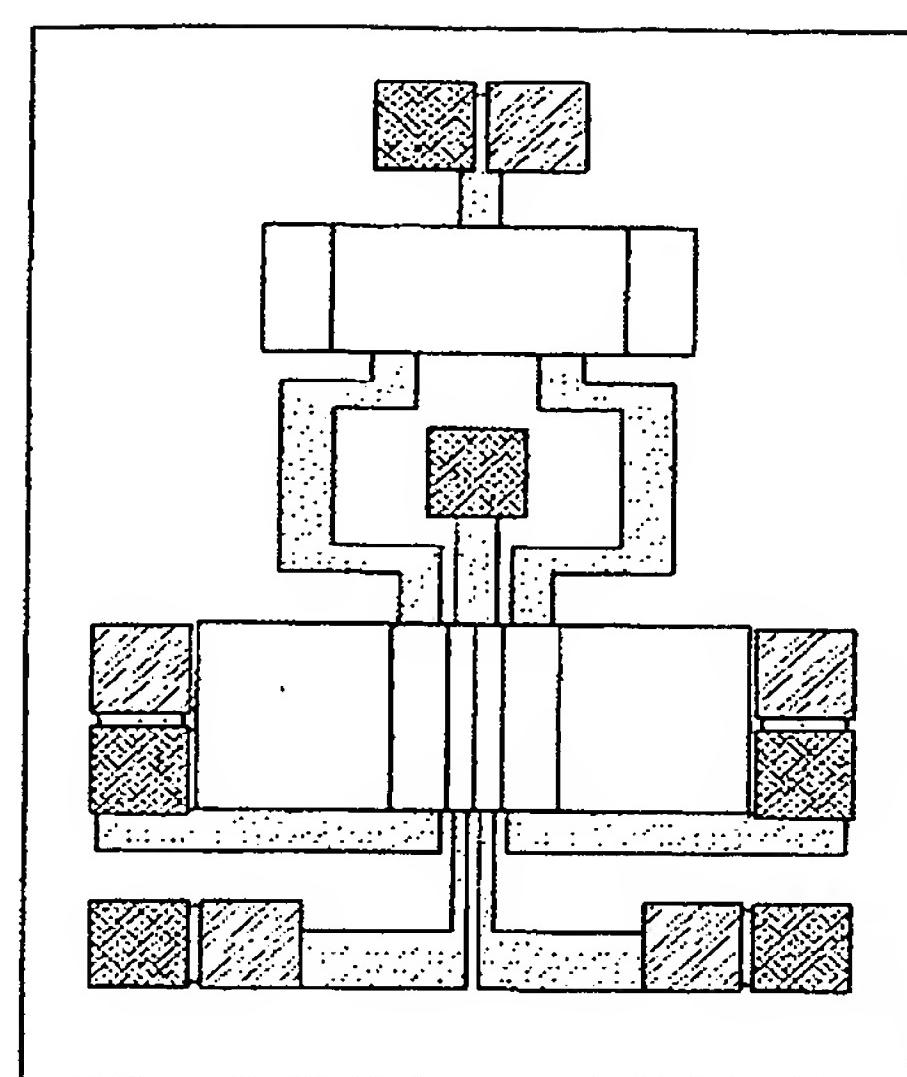
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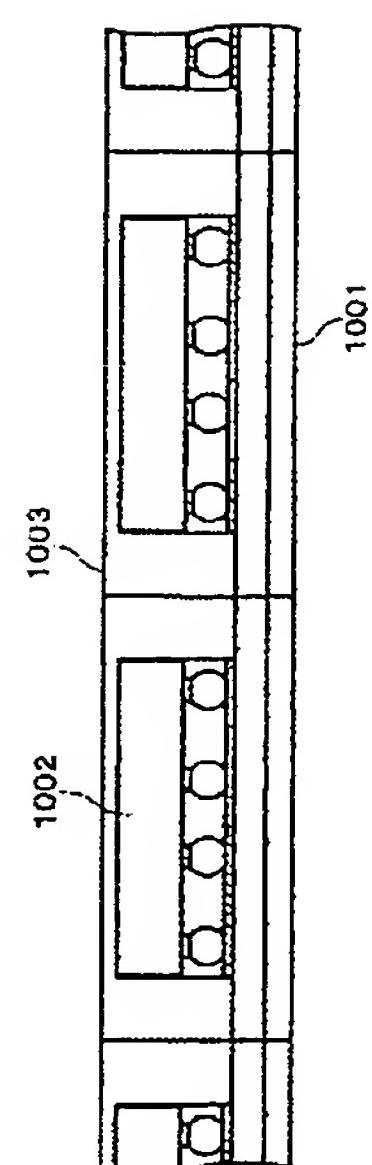
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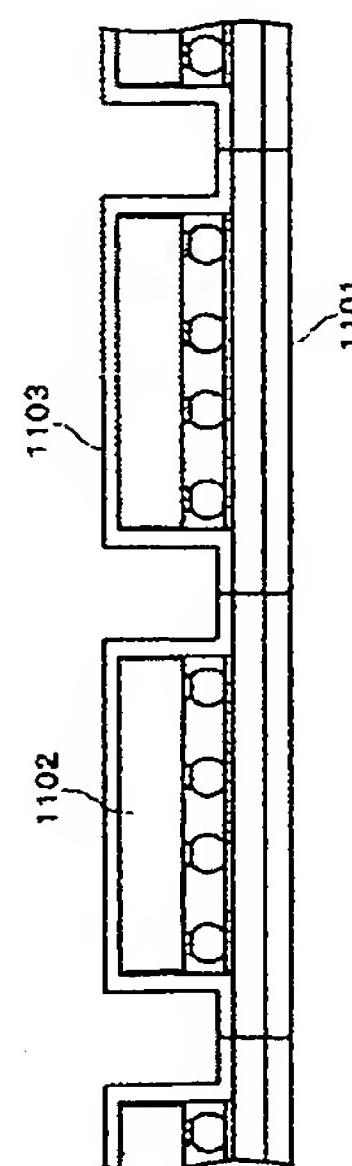
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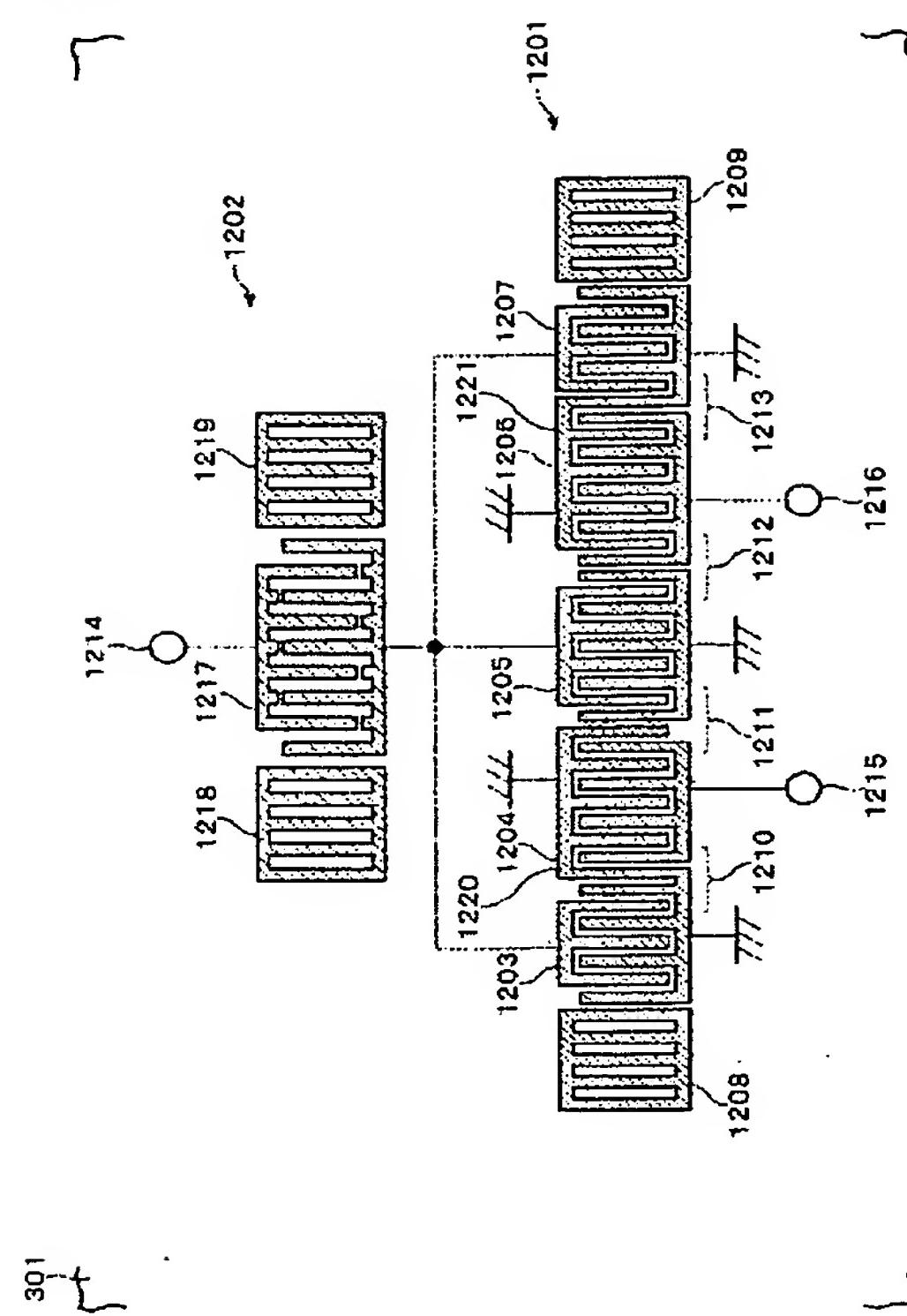
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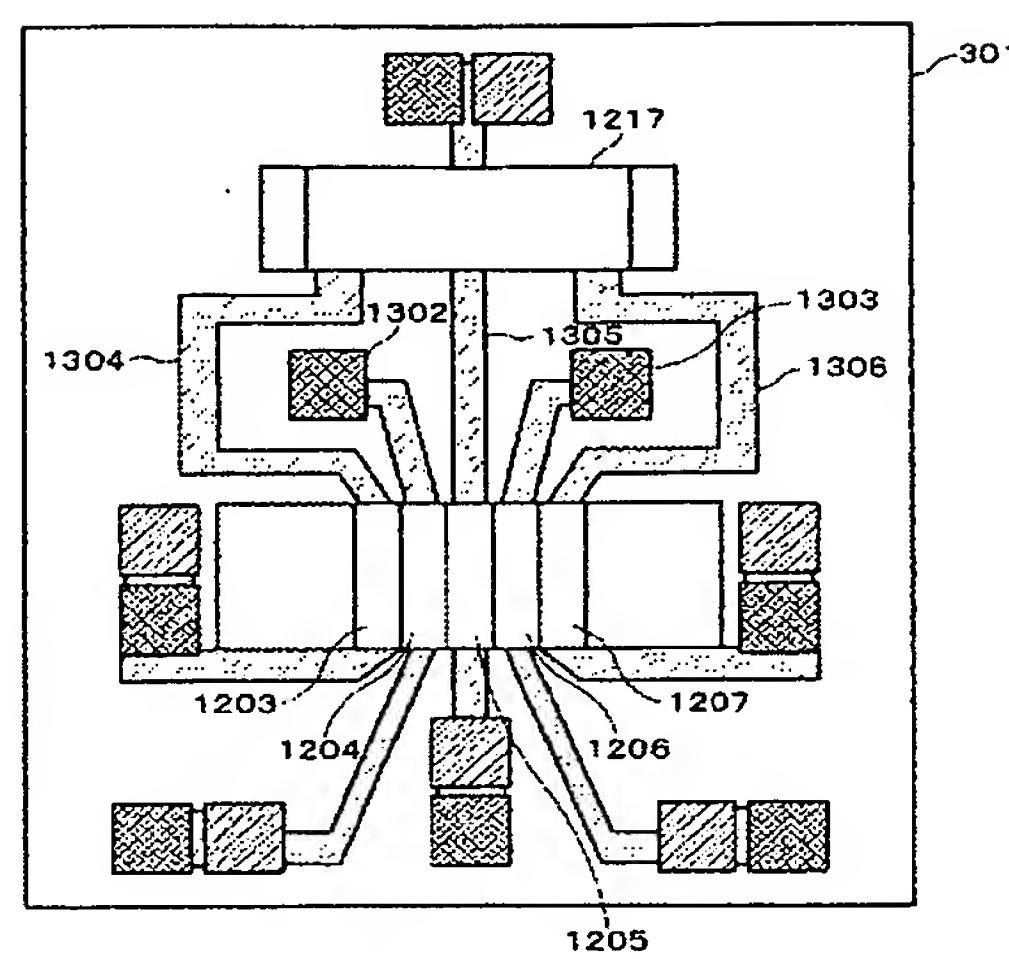
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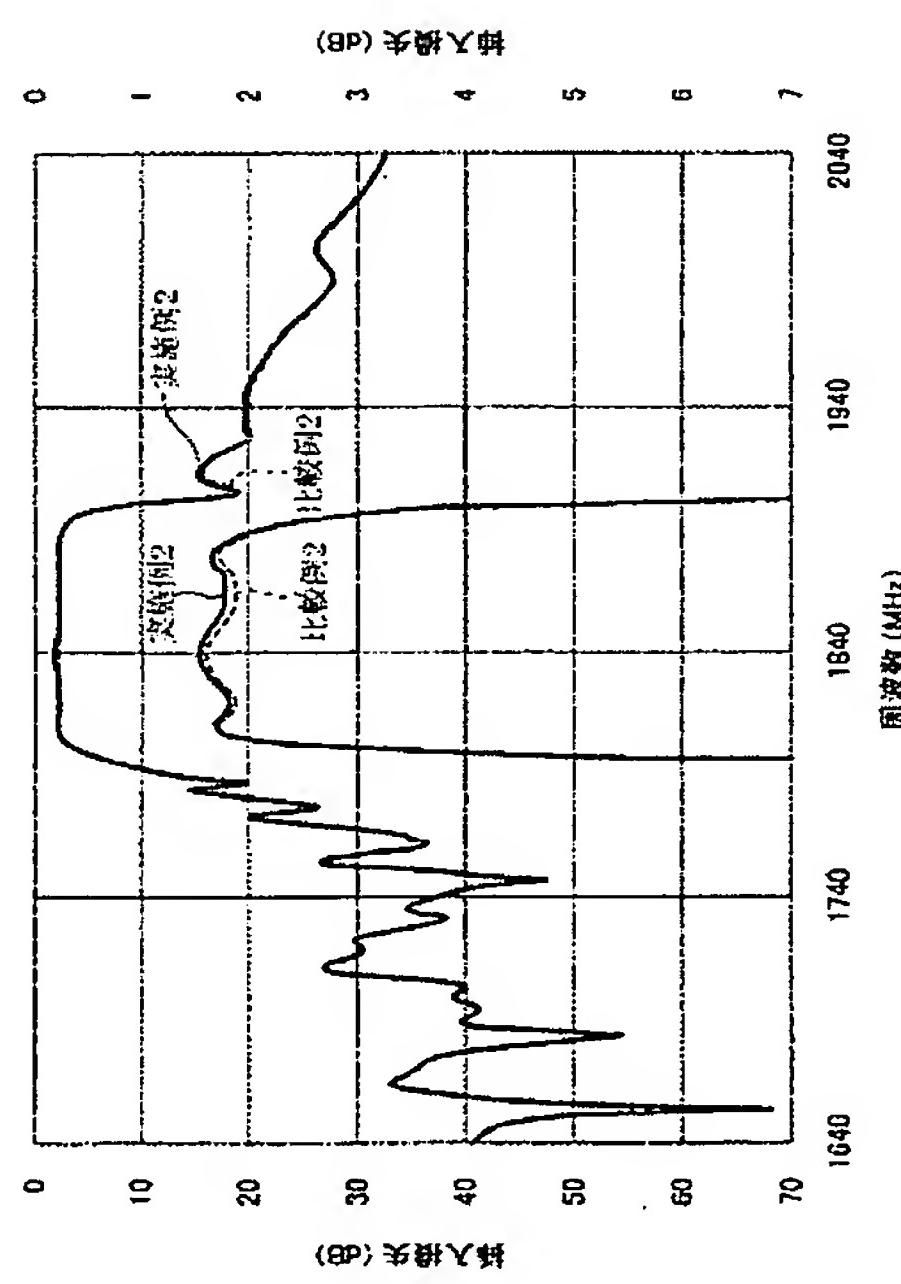
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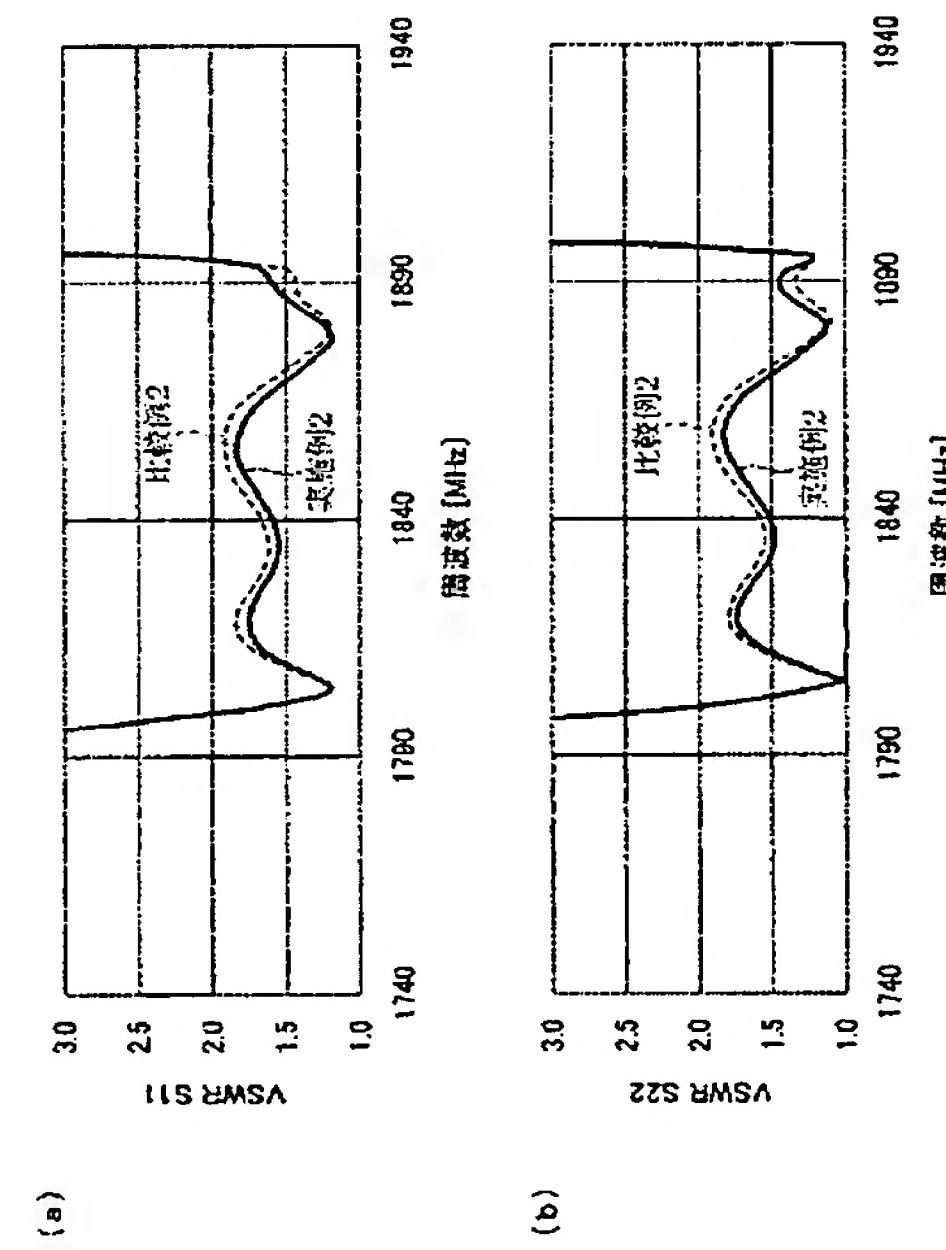
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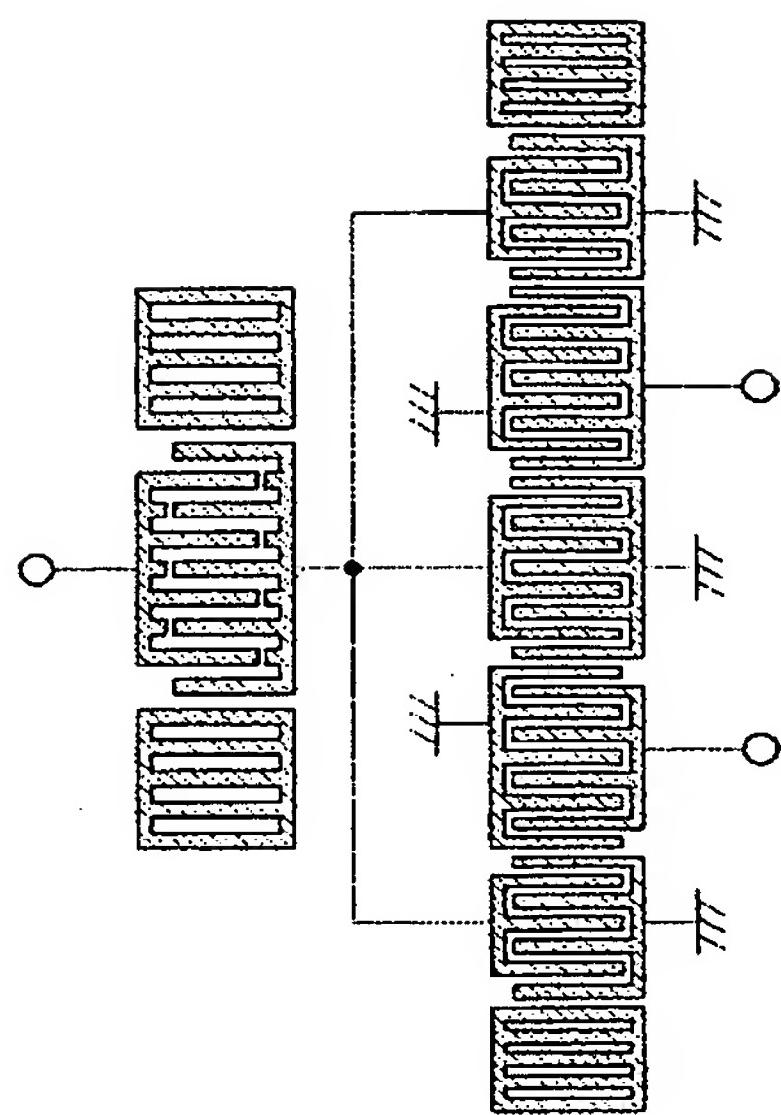
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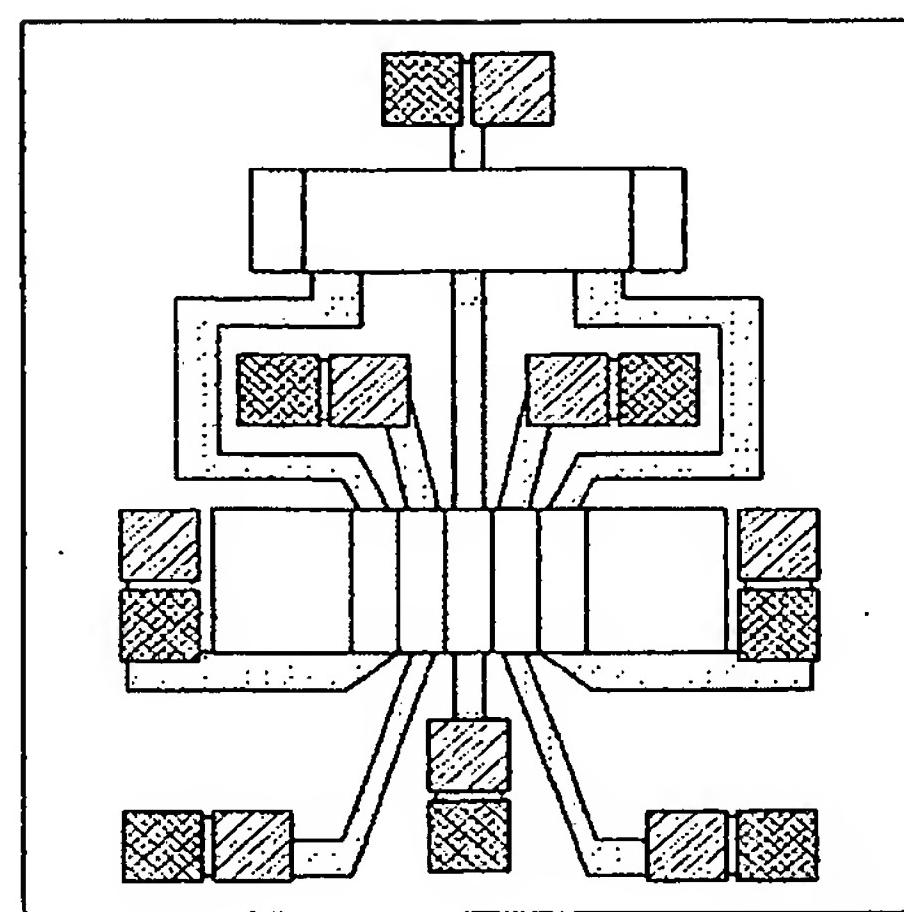
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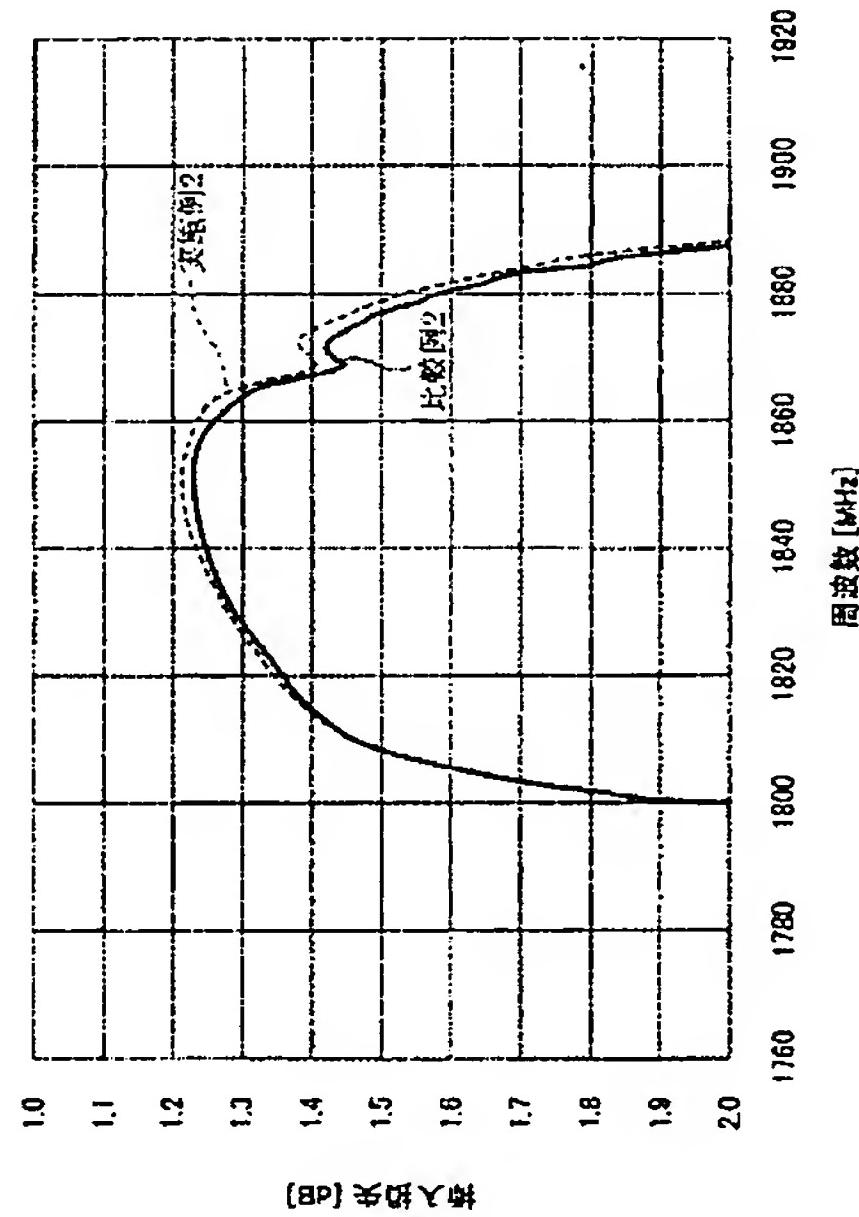
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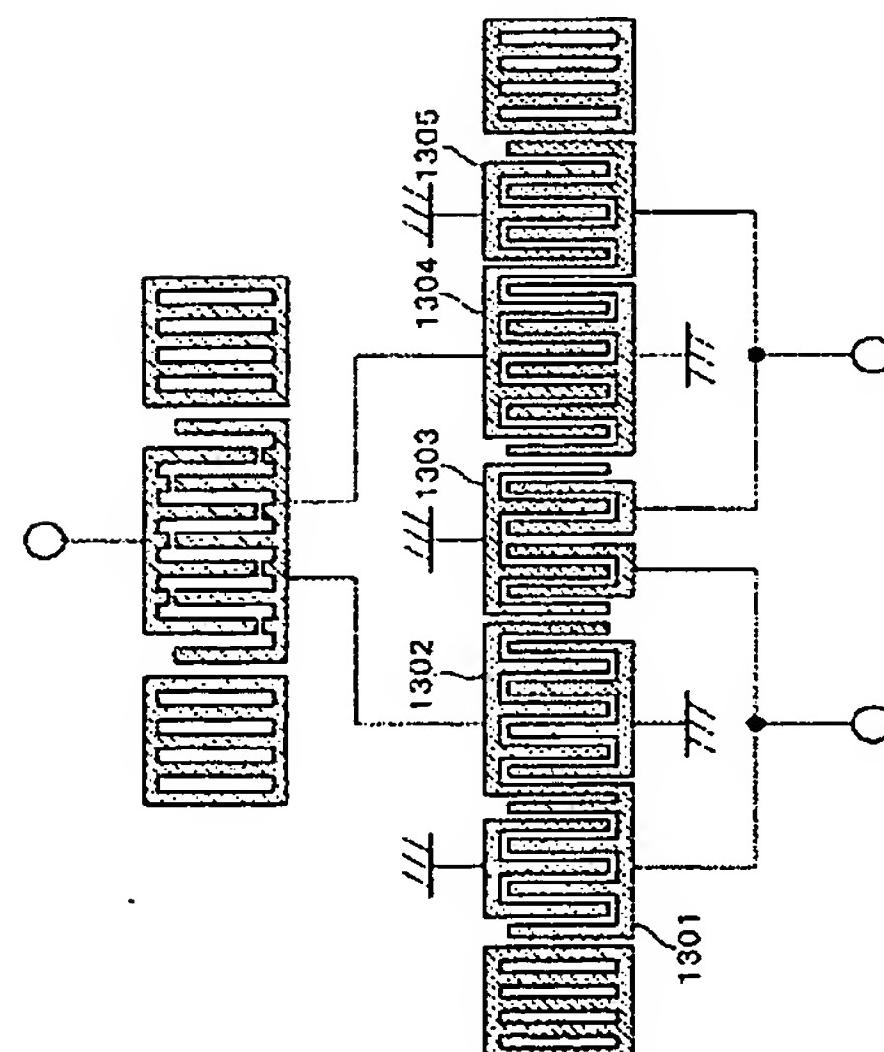
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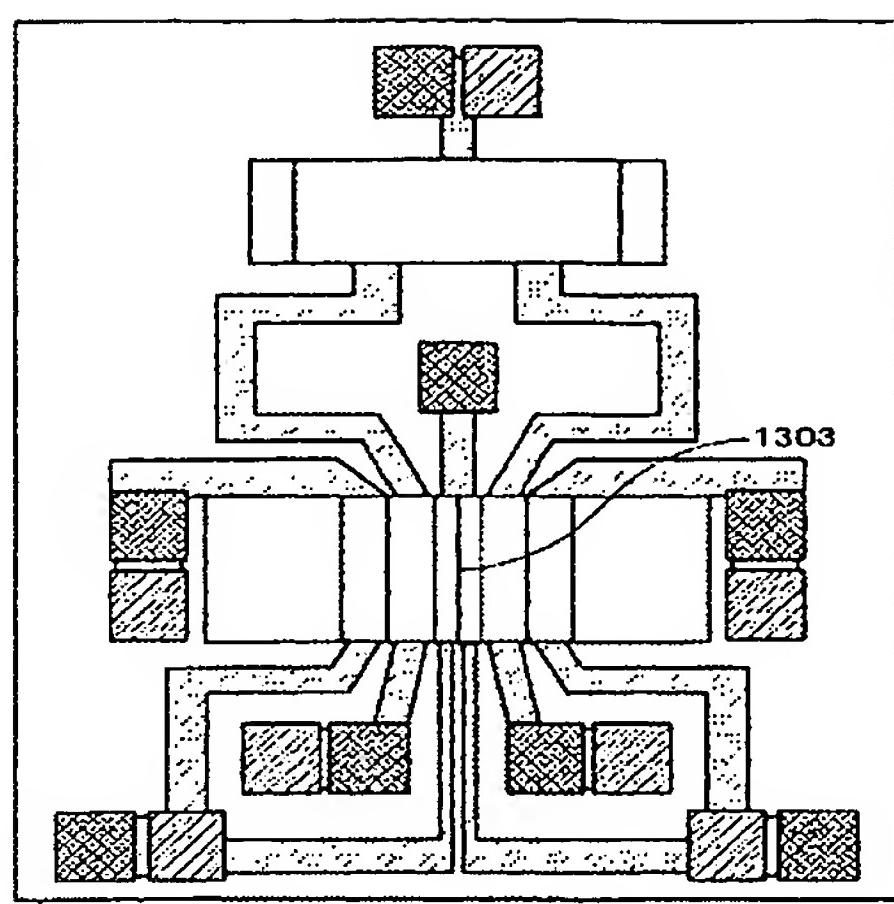
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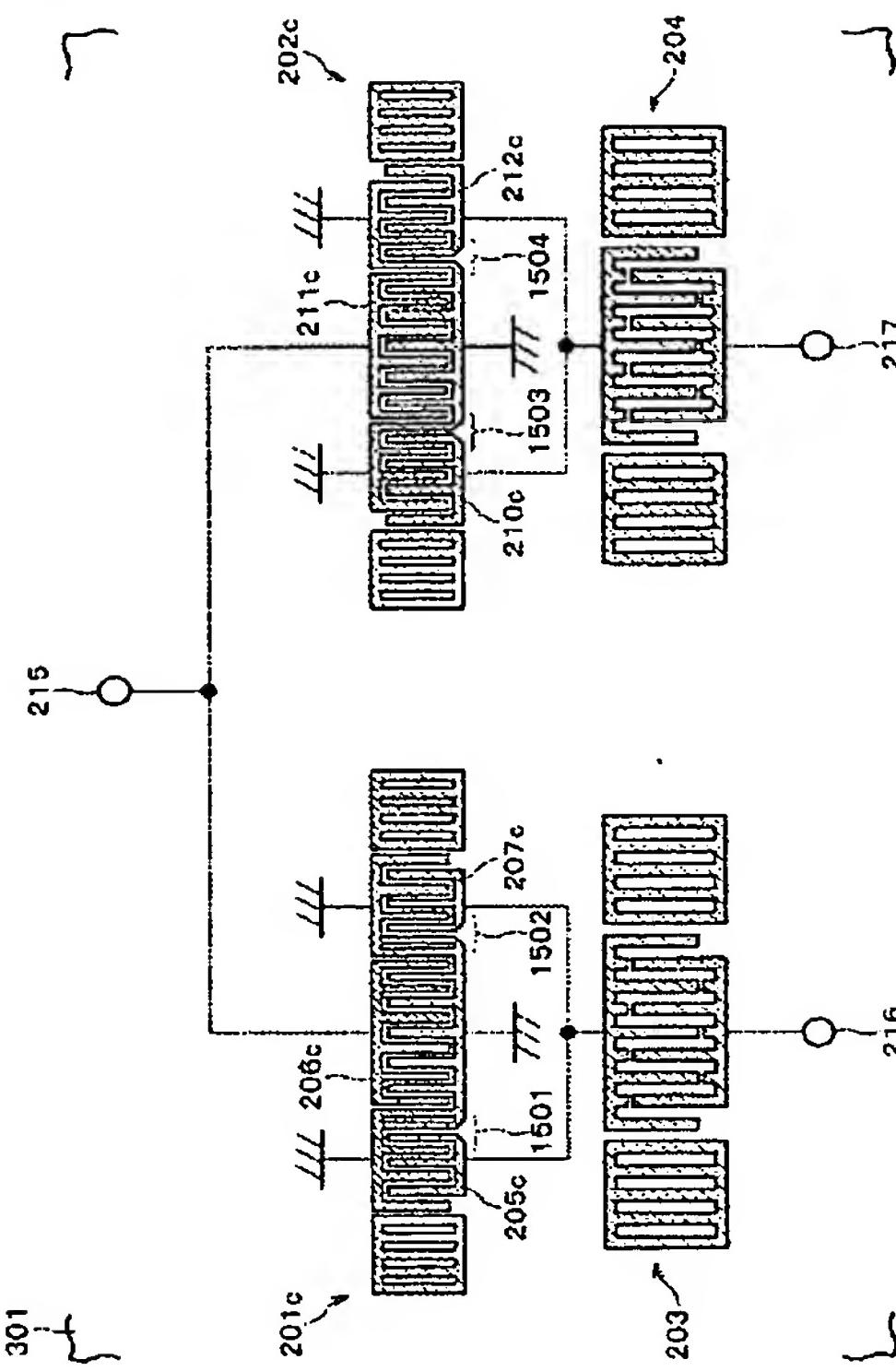
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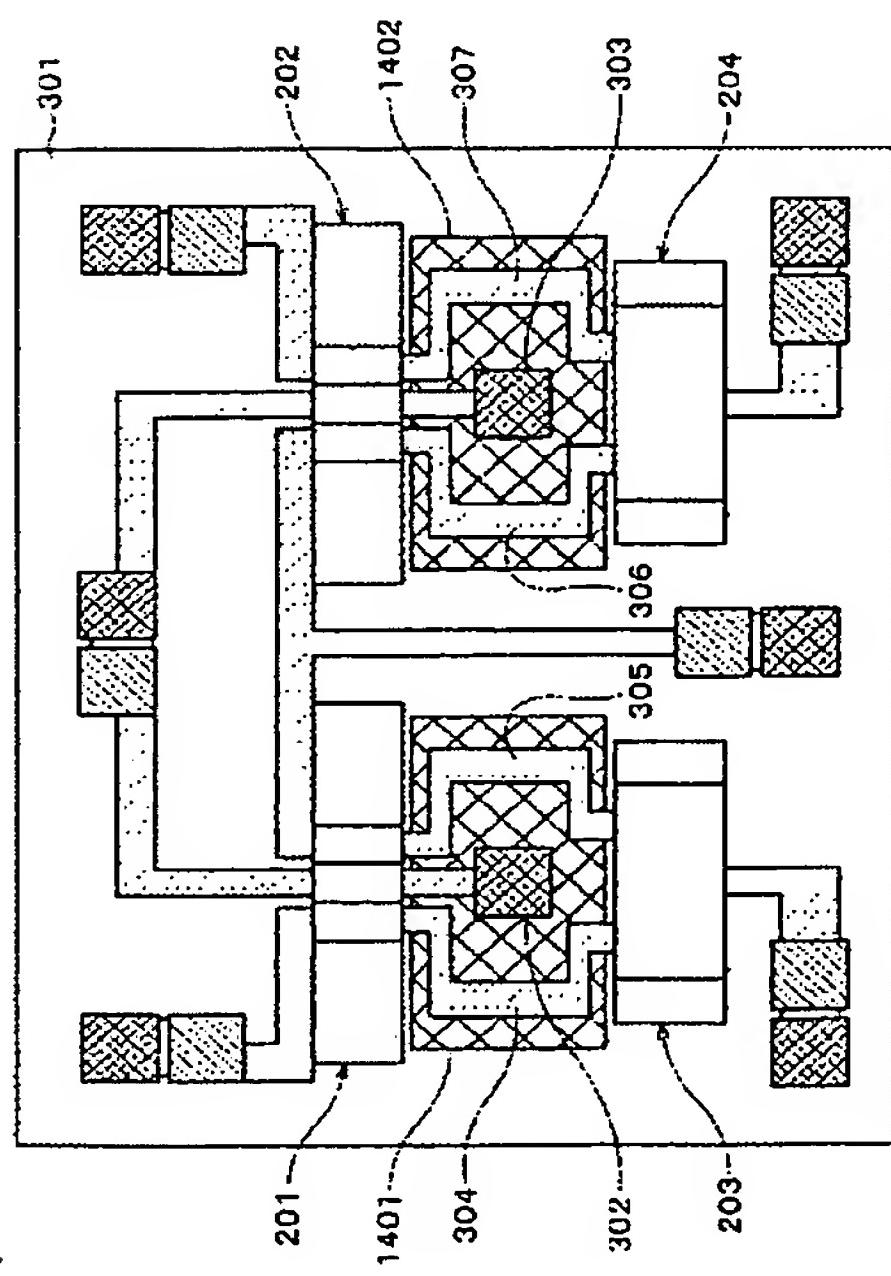
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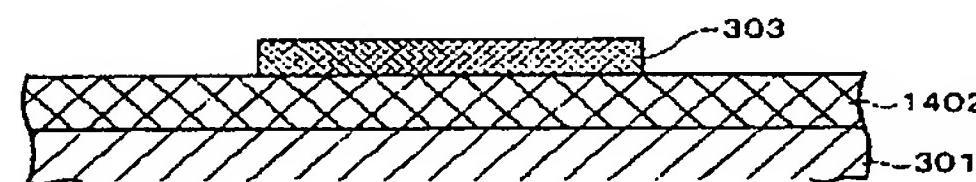
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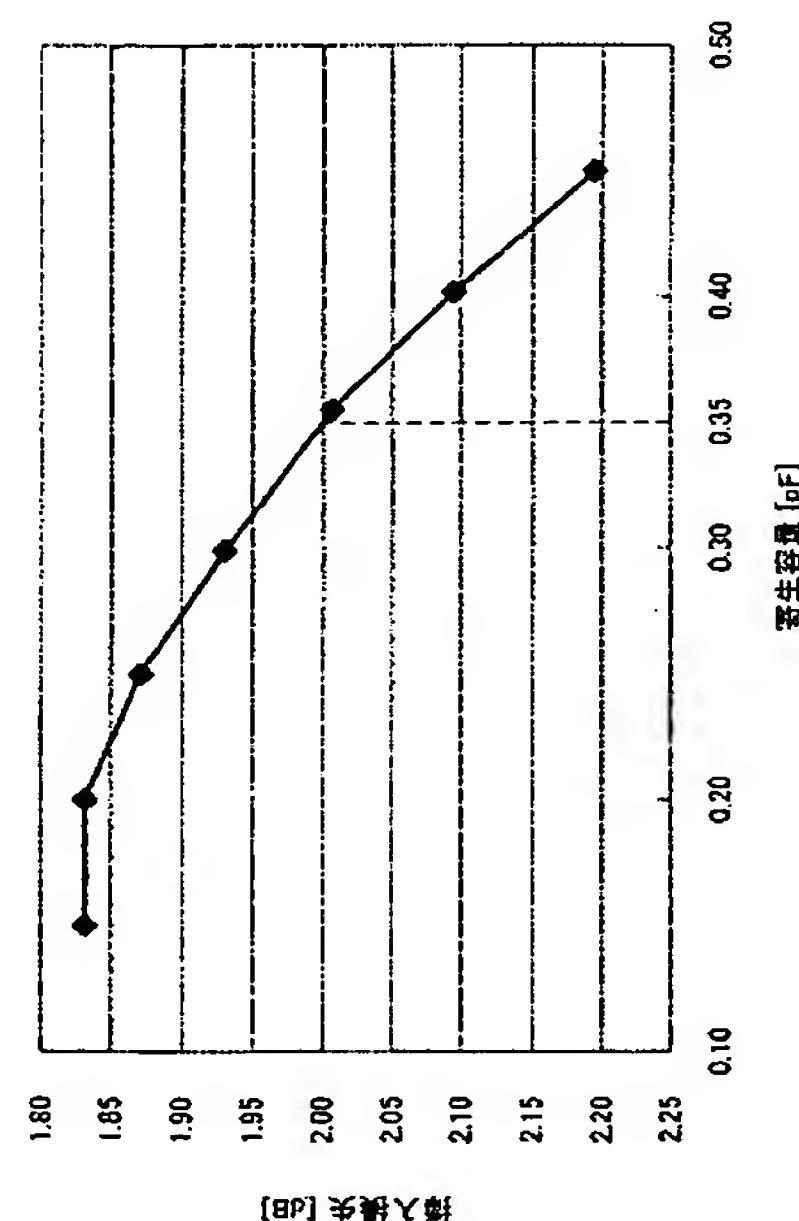
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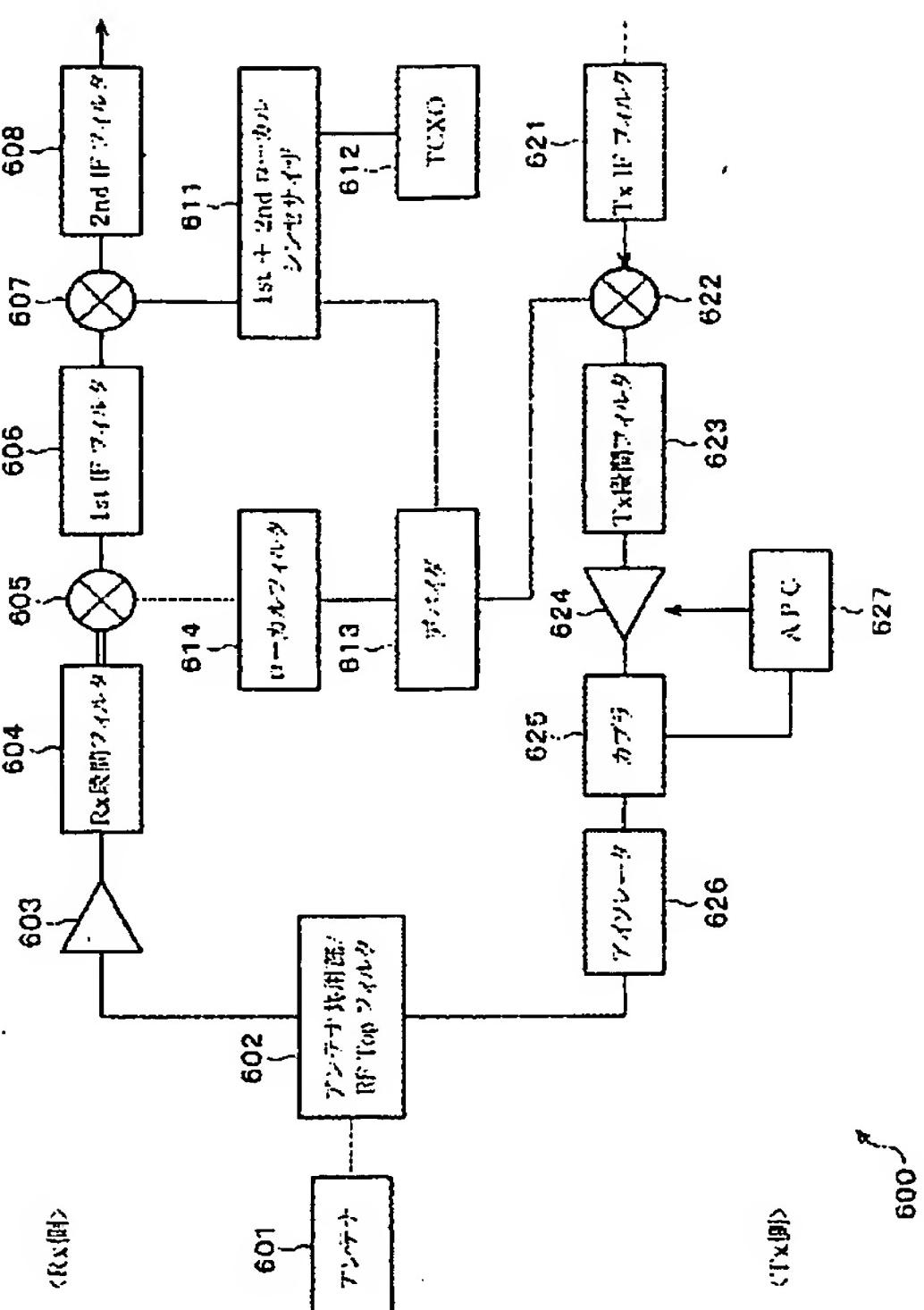
【図32】



【図33】



【図3-4】



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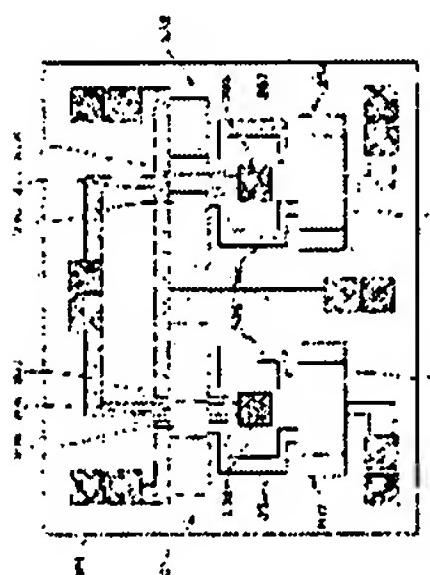
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248204 (71)Applicant : MURATA MFG CO LTD

(22)Date of filing : 28.08.2002 (72)Inventor : TAKAMINE YUICHI

(54) SURFACE ACOUSTIC WAVE DEVICE AND COMMUNICATION
EQUIPMENT



(57)Abstract:

PROBLEM TO BE SOLVED: To provide a surface acoustic wave device for improving the transmitting characteristics of a pass band.

SOLUTION: A transversely coupled resonator type surface acoustic wave filter

201 having at least three comb-shaped electrode parts 205, 206, and 207 is arranged on a piezoelectric substrate 301. At least one surface acoustic wave resonator 203 is arranged on the surface acoustic wave filter 201 so as to be serially connected to at least two comb-shaped electrode parts 205 and 207 of the surface acoustic wave filter 201. The value of a parasitic capacity inserted between the surface acoustic wave filter 201 and the surface acoustic wave resonator 203 is set so as to be $6.5 \times 10^2 / f_0$ [pF] (in this case, f_0 is the central frequency [MHz] of the pass band of the surface acoustic wave filter 201).

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3. In the drawings, any words are not translated.

CLAIMS

[Claim(s)]

[Claim 1]

It has the vertical joint resonator mold surface acoustic wave filter which was formed along the propagation direction of a surface acoustic wave on the piezoelectric substrate and which goes away at least three and has the mold polar zone, and the surface acoustic wave resonator which is this vertical joint resonator mold surface acoustic wave filter and which went away at least two and was connected to the serial to the mold polar zone,

Surface acoustic wave equipment with which the value of the parasitic capacitance which enters between a vertical joint resonator mold surface acoustic wave filter and a surface acoustic wave resonator is characterized by being set to $6.5 \times 10^2 / \text{below } f_0$ [pF] (correcting f_0 being the center frequency [MHz] of the passband of a vertical joint resonator mold surface acoustic wave filter).

[Claim 2]

It has the vertical joint resonator mold surface acoustic wave filter which was formed along the propagation direction of a surface acoustic wave on the piezoelectric substrate and which goes away at least three and has the mold polar zone, and the surface acoustic wave resonator which is this vertical joint resonator mold surface acoustic wave filter and which went away at least two and was connected to the serial to the mold polar zone,

Wiring which is said vertical joint resonator mold surface acoustic wave filter and which goes away at least two and carries out the series connection of the mold polar zone and said surface acoustic wave resonator is arranged so that the ground lateral electrode pad connected to said comb mold polar zone may be surrounded,

Surface acoustic wave equipment characterized by adjoining electrode pads other than this ground lateral electrode pad, and having a pad for property sorting.

[Claim 3]

Said vertical joint resonator mold surface acoustic wave filter has a reflector, The grounding terminal of all comb mold polar zone other than the comb mold polar zone which adjoins the comb mold polar zone connected to said surface acoustic wave resonator among the comb mold polar zone of said vertical joint resonator mold surface acoustic wave filter and said reflector is connected only to one electrode pad,

And surface acoustic wave equipment according to claim 1 or 2 characterized by going away except the comb mold polar zone which adjoins the comb mold polar zone connected to said surface acoustic wave resonator, and said reflector, going away the ground side of the mold polar zone, and communalizing the mold electrode with the electrode finger.

[Claim 4]

Surface acoustic wave equipment given in claim 1 thru/or any 1 term of 3 to which said vertical joint resonator mold surface acoustic wave filter is characterized by three or for five going away and having the mold polar zone.

[Claim 5]

In the part where it goes away the ground side of the comb mold polar zone which adjoins the comb mold polar zone in said vertical joint resonator mold surface acoustic wave filter which goes away the signal side of the comb mold polar zone connected to said surface acoustic wave resonator, and is connected with the mold electrode at this aforementioned surface acoustic wave resonator, and the mold electrode adjoins each other mutually,

Surface acoustic wave equipment given in claim 1 thru/or any 1 term of 4 characterized by making the bus bar of a comb mold electrode thin.

[Claim 6]

The electrode pad connected to the grounding terminal of the comb mold polar zone arranged at the side to which said surface acoustic wave resonator in said vertical joint resonator mold surface acoustic wave filter is connected, The earth line which has connected the grounding terminal and electrode pad of the comb mold polar zone, And surface acoustic wave equipment given in claim 1 thru/or any 1 term of 5 characterized by preparing an insulating layer between at least one and the piezo-electric substrates of a signal line which have connected said vertical joint resonator mold surface acoustic wave filter and said surface acoustic wave resonator.

[Claim 7]

Surface acoustic wave equipment given in claim 1 thru/or any 1 term of 6 characterized by giving balanced - unbalance conversion function to said surface acoustic wave equipment.

[Claim 8]

Surface acoustic wave equipment given in claim 1 thru/or any 1 term of 7 to which said piezo-electric substrate is characterized by being contained in a package by the face down method of construction.

[Claim 9]

The communication device characterized by having surface acoustic wave equipment of a publication in claim 1 thru/or any 1 term of 8.

[Translation done.]

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DETAILED DESCRIPTION

[Detailed Description of the Invention]

[0001]

[Field of the Invention]

This invention relates to the surface acoustic wave equipment which can improve a transmission characteristic, and the communication device using it.

[0002]

[Description of the Prior Art]

The technical progress of a portable telephone (communication device) in recent years has a remarkable thing. In order to realize this, the surface acoustic wave equipment used for RF stage of a portable telephone is also asked for high performance-ization. The configuration which carries out the series connection of the surface acoustic wave resonator is widely used to the surface acoustic wave filter, especially the vertical joint resonator mold surface acoustic wave filter as it considers as the technique of high-performance-izing surface acoustic wave equipment, for example, is indicated by JP,7-30367,A.

[0003]

This schematic diagram is shown in drawing 3 . Three configurations of drawing 3 go away and the surface acoustic wave resonator 102 is connected to the serial to the mold polar-zone (henceforth IDT) type vertical joint resonator mold surface acoustic wave filter 101. that time -- the frequency relation between the vertical joint resonator mold surface acoustic wave filter 101 and the surface acoustic wave resonator 102 is set up so that the antiresonant frequency of the surface acoustic wave resonator 102 may be located in a RF side from the

passband of the vertical joint resonator mold surface acoustic wave filter 101 and resonance frequency may be located in a passband.

[0004]

Since the nearby magnitude of attenuation becomes large very much a passband RF side by this since the antiresonant frequency of the surface acoustic wave resonator 102 is located in a RF side from the passband of the vertical joint resonator mold surface acoustic wave filter 101, and resonance frequency is located in a passband, big degradation of the insertion loss in a passband is not produced.

[0005]

In order to remove conventionally the defective generated in a production process in manufacture of surface acoustic wave equipment, property sorting in a wafer phase may be performed in addition to the completion phase of a product. It is because carrying in a package to the component of a defective being lost, consequently making a package useless is lost and cost reduction becomes possible by removing the defective of a component in a wafer phase by this.

[0006]

In order to perform property sorting in this wafer phase by the measurement using a needlelike probe, the pad for property sorting of dedication (following and 1 ** pad) is prepared. In order to reduce the capacity generated from leading about etc., this 1 ** pad adjoins each electrode pad for a flow with a package, and is prepared in many cases. In addition, the reason for preparing 1 ** pad independently is for each above-mentioned electrode pad to get damaged by contact at the head of a probe, and to tend to generate nonconformity in connection with a package, when measurement by the probe is performed using each above-mentioned electrode pad.

[0007]

The example of the layout on a piezo-electric substrate in the case of realizing actually the surface acoustic wave equipment of the configuration of drawing 3 is shown in drawing 4 R> 4. In drawing 4 , 1 ** pad for the electrode pad for bump

bond or wire bond in the rectangular head shown in the slanting grid and the rectangular head of a slash to measure and sort out a filter property using a probe in the state of a wafer is shown.

[0008]

[Problem(s) to be Solved by the Invention]

However, with the configuration of drawing 3 , there was a problem that the insertion loss in a passband got worse, compared with the configuration which does not carry out the series connection of the surface acoustic wave resonator 102. As a result of investigating this cause, it turned out that the parasitic capacitance with which the cause of worsening the insertion loss in a passband enters between the vertical joint resonator mold surface acoustic wave filter 101 and the surface acoustic wave resonator 102 (it generates) has influenced.

[0009]

That is, as shown in drawing 4 , in the structure which carries out the series connection of the surface acoustic wave resonator 102 to at least two IDT(s) of the surface acoustic wave filter 101, each two signal lines 103 and 104 which are wiring which connects them become the layout which surrounds the electrode pad 105 and 1 ** pad 106. Big parasitic capacitance occurred by this between these two signal lines 103 and 104, and the electrode pad 105 and 1 ** pad 106, and it turned out that that this parasitic capacitance is large is the cause of worsening the insertion loss in a passband.

[0010]

Like drawing 3 , the object of this invention proposes the layout on the piezo-electric substrate which can reduce parasitic capacitance in the configuration which carried out the series connection of the surface acoustic wave resonator 102 to the vertical joint resonator mold surface acoustic wave filter 101, and the insertion loss in a passband is to offer good surface acoustic wave equipment.

[0011]

[Means for Solving the Problem]

The vertical joint resonator mold surface acoustic wave filter which has at least

three IDT(s) formed along the propagation direction of a surface acoustic wave on the piezo-electric substrate in order that the surface acoustic wave equipment of this invention may solve the above technical problem, It has the surface acoustic wave resonator connected to the serial to at least two IDT(s) of this vertical joint resonator mold surface acoustic wave filter. The value of the parasitic capacitance which enters between a vertical joint resonator mold surface acoustic wave filter and a surface acoustic wave resonator is characterized by being set to 6.5×10^2 /below f0 [pF] (correcting, f0 being the center frequency [MHz] of the passband of a vertical joint resonator mold surface acoustic wave filter).

[0012]

Since the value of the parasitic capacitance which enters between a vertical joint resonator mold surface acoustic wave filter and a surface acoustic wave resonator was set to 6.5×10^2 /below f0 [pF] according to the above-mentioned configuration, the increment in the insertion loss resulting from the above-mentioned parasitic capacitance and degradation of VSWR can be controlled, and the insertion loss in a passband is good and can offer surface acoustic wave equipment excellent in the transmission characteristic.

[0013]

The vertical joint resonator mold surface acoustic wave filter which has at least three IDT(s) formed along the propagation direction of a surface acoustic wave on the piezo-electric substrate in order that other surface acoustic wave equipments of this invention may solve the above technical problem, It has the surface acoustic wave resonator connected to the serial to at least two IDT(s) of this vertical joint resonator mold surface acoustic wave filter. Wiring which carries out the series connection of at least two IDT(s) and said surface acoustic wave resonator of said vertical joint resonator mold surface acoustic wave filter It is arranged so that the ground lateral electrode pad connected to said IDT may be surrounded, and it is characterized by having the pad for property sorting adjoined and connected to electrode pads other than this ground lateral electrode

pad.

[0014]

Since it has the pad for property sorting adjoined and connected to an electrode pad according to the above-mentioned configuration, through the above-mentioned pad for property sorting, the property of surface acoustic wave equipment is inspected with a probe, and the above-mentioned surface acoustic wave equipment can be sorted out from the inspection result.

[0015]

Moreover, since the pad for property sorting is adjoined and connected to electrode pads other than the ground lateral electrode pad connected to said IDT surrounded with wiring which carries out the series connection of at least two IDT(s) and said surface acoustic wave resonator of said vertical joint resonator mold surface acoustic wave filter with the above-mentioned configuration, it is avoidable that the above-mentioned pad for property sorting adjoins the ground lateral electrode pad which is surrounded with said wiring and which is connected to said IDT.

[0016]

Since the increment in the parasitic capacitance which originates in the pad for property sorting adjoining a ground lateral electrode pad in the above-mentioned configuration by this can be prevented and the above-mentioned parasitic capacitance can be set for example, to 6.5×10^{-2} /below f_0 [pF], the increment in the insertion loss resulting from the above-mentioned parasitic capacitance and degradation of VSWR can be controlled, and the insertion loss in a passband is good and can offer surface acoustic wave equipment excellent in the transmission characteristic.

[0017]

With the above-mentioned surface acoustic wave equipment, said vertical joint resonator mold surface acoustic wave filter has a reflector. All grounding terminals of IDT other than IDT which adjoins IDT connected to said surface acoustic wave resonator among IDT(s) of said vertical joint resonator mold

surface acoustic wave filter and said reflector are connected only to one electrode pad. It is desirable that go away the ground side of IDT(s) other than IDT which adjoins IDT connected to said surface acoustic wave resonator and said reflector, and the mold electrode is communalized with the electrode finger.

[0018]

According to the above-mentioned configuration, since it goes away the ground side of IDT(s) other than IDT which adjoins IDT connected to the surface acoustic wave resonator, and said reflector and the mold electrode is communalized with the electrode finger, said pad for property sorting can carry out [certain]-izing of the evasion of adjoining the ground lateral electrode pad connected to said IDT surrounded with said wiring.

[0019]

Since the increment in the parasitic capacitance which originates in the pad for property sorting adjoining a ground lateral electrode pad in the above-mentioned configuration by this can be prevented more certainly and the above-mentioned parasitic capacitance can be set for example, to 6.5×10^2 /below f0 [pF], the increment in the insertion loss resulting from the above-mentioned parasitic capacitance and degradation of VSWR can be controlled, and the insertion loss in a passband is good and can offer more certainly surface acoustic wave equipment excellent in the transmission characteristic.

[0020]

In the above-mentioned surface acoustic wave equipment, it is desirable for said vertical joint resonator mold surface acoustic wave filter to have three or five IDT(s).

[0021]

With the above-mentioned surface acoustic wave equipment, the bus bar of a comb mold electrode may be made thinner than other parts in the part where it goes away the ground side of IDT which adjoins IDT which goes away the signal side of IDT connected to said surface acoustic wave resonator of said vertical joint resonator mold surface acoustic wave filter, and is connected with the mold

electrode at this aforementioned surface acoustic wave resonator, and the mold electrode adjoins each other mutually.

[0022]

In the part which adjoins each other mutually, by having made the bus bar of a comb mold electrode thinner than other parts, the aforementioned parasitic capacitance can be reduced, the increment in the insertion loss resulting from the above-mentioned parasitic capacitance and degradation of VSWR can be controlled, and the insertion loss in a passband is good and, according to the above-mentioned configuration, can offer more certainly surface acoustic wave equipment excellent in the transmission characteristic.

[0023]

In the above-mentioned surface acoustic wave equipment, an insulating layer may prepare between at least one and the piezo-electric substrates of the earth line which has connected the electrode pad connected to the grounding terminal of the comb mold polar zone arranged at the side to which said surface acoustic wave resonator in said vertical joint resonator mold surface acoustic wave filter is connected, and the grounding terminal and the electrode pad of the comb mold polar zone, and the signal line which has connected said vertical joint resonator mold surface acoustic wave filter and said surface acoustic wave resonator.

[0024]

According to the above-mentioned configuration, a parasitic capacitance value can be reduced by preparing an insulating layer with a dielectric constant smaller than a piezo-electric substrate between at least one and the piezo-electric substrates of an electrode pad, an earth line, and a signal line, and a property can be improved.

[0025]

Balanced - unbalance conversion function may be given to said surface acoustic wave equipment with the above-mentioned surface acoustic wave equipment. In the above-mentioned surface acoustic wave equipment, said piezo-electric substrate may be contained in the package by the face down method of

construction.

[0026]

The communication device of this invention is characterized by having surface acoustic wave equipment given in above any they are, in order to solve the aforementioned technical problem. Since it has the surface acoustic wave equipment equipped with the outstanding transmission characteristic with which the insertion loss was reduced according to the above-mentioned configuration, a communication link property can be improved.

[0027]

[Embodiment of the Invention]

It will be as follows if each example concerning the surface acoustic wave equipment of this invention is explained based on drawing 1 , drawing 2 , drawing 5 , or drawing 33 .

[0028]

(Example 1)

The configuration of the example 1 of this invention is explained using drawing 1 , drawing 2 , and drawing 5 . In addition, each future example explains taking the case of the filter for DCS reception (center frequency of a passband: 1842.5 MHz). First, the electrode configuration of an example 1 is explained using drawing 2 .

[0029]

In the example 1, as shown in drawing 2 , each surface acoustic wave resonators 203 and 204 connected to the serial to each vertical joint resonator mold surface acoustic wave filters 201 and 202 and each vertical joint resonator mold surface acoustic wave filters 201 and 202, respectively are formed with the aluminum (aluminum) electrode on the piezo-electric substrate 301 which consists of 40 **5-degreeYcutX propagation LiTaO₃.

[0030]

As for each vertical joint resonator mold surface acoustic wave filters 201 and 202, it is desirable from the ability to attain a miniaturization to be arranged along

the propagation direction of those surface acoustic waves. It is desirable by the ability attaining a miniaturization to be arranged along the propagation direction of those surface acoustic waves also about each surface acoustic wave resonators 203 and 204. The configuration of an example 1 is surface acoustic wave equipment which gave balanced - unbalance conversion function using each vertical joint resonator mold surface acoustic wave filters 201 and 202.

[0031]

the configuration of the vertical joint resonator mold surface acoustic wave filter 201 puts IDT(comb mold polar zone) 206 from both sides along the propagation direction of a surface acoustic wave -- as -- every -- IDT 205 and 207 is formed, respectively and reflectors 208 and 209 are further formed in those both sides, respectively.

[0032]

IDT205 wanted to have the parallel electrode finger of each other of plurality which is prolonged in the direction which intersects perpendicularly from the band-like end face section (bus bar) and one flank of the end face section, was carried out, is equipped with two mold electrodes, and has each above-mentioned comb mold electrode in the condition of having become intricate between mutual electrode fingers so that the flank of the electrode finger of each above-mentioned comb mold electrode might be met mutually.

[0033]

In such IDT205, a signal transformation property and setting out of a passband are possible by setting up the decussation width of face which shows the die length and width of face of each electrode finger, spacing of each adjacent electrode finger, and the confrontation die length in the condition between mutual electrode fingers of having become intricate, respectively. Moreover, it is the same as that of IDT205 about each of other IDT. A reflector has the function reflected in the direction which has spread the spread surface acoustic wave.

[0034]

The pitch of several electrode fingers between IDT205 and IDT206 and between

IDT206 and IDT207 is set up smaller than other parts of IDT so that it may turn out that drawing 2 is moreover seen (218 of drawing 2 , 219 parts).

[0035]

Although the configuration of the vertical joint resonator mold surface acoustic wave filter 202 is fundamentally the same as the vertical joint resonator mold surface acoustic wave filter 201, each points that those phases are reversed to IDT 205 and 207, as for each IDT 210 and 212 differ. The unbalance signal terminal 215, each IDT 205 and 207, and each IDT 210 and 212 are connected to each balanced signal terminals 216 and 217 for each IDT 206 and 211 through each surface acoustic wave resonators 203 and 204, respectively.

[0036]

With the configuration of the surface acoustic wave resonator 203, each reflectors 222 and 224 are formed, respectively so that IDT223 may be put from both sides along the propagation direction of a surface acoustic wave. The configuration of the surface acoustic wave resonator 204 is the completely same configuration as the surface acoustic wave resonator 203. The layout on the actual piezo-electric substrate 301 of the configuration of an example 1 is shown in drawing 1 . In drawing 1 , the part corresponding to drawing 2 is shown using the same member number. In drawing 1 , the rectangular head of the electrode pad for bump bond for the rectangular head of a slanting grid to take a package and a flow and a slash is 1 ** pad.

[0037]

As shown in drawing 5 , the surface acoustic wave equipment of an example 1 takes a flow for between the electrode surface of the piezo-electric substrate 301, and the diamond touch sides 403 of a package 400 by the bump 406, and it is produced using the face down method of construction which secures space 405 on the electrode surface of the piezo-electric substrate 301 so that generating of the surface acoustic wave in the piezo-electric substrate 301 may not be checked. The package 400 has a bottom plate 401, the side-attachment-wall section 402, and cap 404.

[0038]

The description of an example 1 IDT 205 and 207, IDT223 and IDT 210 and 212, and IDT226 in drawing 1 to each grounding terminal of IDT 206 and 211 between each leading about 304 and 305 connected, respectively and each leading about 306 and 307 It is only each electrode pads 302 and 303 for bump bond having been connected, respectively, and 1 ** pad's being excluded, and having adjoined each above-mentioned electrode pad 302 and each electrode pad other than 303, and having prepared 1 side pad, respectively.

[0039]

Approaching mutually and adjoining the above-mentioned contiguity also contains. Moreover, since being prepared on leading about which connects each signal terminal of IDT and a grounding terminal, and each electrode pad corresponding to them can avoid becoming long beyond the need about leading about, 1 ** pad to prepare has it. [desirable]

[0040]

The grounding terminal (ground side comb mold electrode) of IDT 205 and 207 sets in 228 or 229 parts (part which adjoins each other mutually). in connection with it, it is shown in drawing 2 -- as -- the grounding terminal (ground side comb mold electrode) of IDT206, and every -- the grounding terminal (ground side comb mold electrode) of IDT211, and every -- the grounding terminal (ground side comb mold electrode) of IDT 210 and 212 -- 230 or 231 parts (part which adjoins each other mutually) -- setting -- an electrode finger -- using -- communalization -- that is, it connects mutually.

[0041]

By this, even if it connects, respectively and does not prepare 1 ** pad in each grounding terminal of IDT 206 and 211 1 ** pad of IDT 210 and 212 connected to which grounding terminal at least is minded. every -- IDT 205 and 207 -- at least - - which grounding terminal and every -- The filter shape of the produced surface acoustic wave equipment can be checked in the state of a wafer, and property sorting about each above-mentioned surface acoustic wave equipment of a wafer

condition can be performed promptly, respectively.

[0042]

If the detailed design of each vertical joint resonator mold surface acoustic wave filters 201 and 202 sets to lambdal wavelength decided by the pitch of the electrode finger which has not made the pitch small,

Decussation width of face: 41.8lambdal

IDT number (order of 205, 206, and 207): -- (3)1818(3) / (3)33(3) (number of the electrode finger with which the inside of a parenthesis made the pitch small)

Reflector number: 60 (201) and 90 (202)

duty: -- 0.72 (IDT) and 0.57 (reflector)

Electrode-layer thickness: 0.092lambdal

The detailed design of the surface acoustic wave resonators 403 and 404 is as follows.

Decussation width of face: 34.9lambdal

IDT number: 250

Reflector number: 30

duty:0.60

Electrode-layer thickness: 0.093lambdal

Next, an operation and effectiveness of the surface acoustic wave equipment concerning this example 1 are explained. The frequency-transmission characteristic of the configuration of an example 1 and a frequency-VSWR property are shown in drawing 6 and drawing 7 . The frequency-transmission characteristic of the configuration of the example 1 of a comparison shown in drawing 8 R> 8 and drawing 9 as a comparison and a frequency-VSWR property are also shown.

[0043]

the configuration of the example 1 of a comparison -- every given in an example 1 -- the grounding terminal of IDT 205-207, and every -- every which separated the grounding terminal of IDT 210-212 mutually, respectively -- IDT(s) 205a-207a and every -- 1 ** pads 501 and 502 are further formed in the grounding terminal

of IDT(s) 206a and 211a using each vertical joint resonator mold surface acoustic wave filters 201a and 202a equipped with IDT(s) 210a-212a. All the other design parameters etc. are the same.

[0044]

Incidentally, compared with the example 1 of a comparison, the parasitic capacitance which enters in the example 1 between the vertical joint resonator mold surface acoustic wave filter 202 and the surface acoustic wave resonator 204 between the vertical joint resonator mold surface acoustic wave filter 201 and the surface acoustic wave resonator 203 is small about 0.1pF. The magnitude of the parasitic capacitance of the example 1 shown in drawing 1 and drawing 2 was about 0.30pF, and the magnitude of the parasitic capacitance of the example 1 (drawing 8 , drawing 9) of a comparison was about 0.40pF.

[0045]

When drawing 6 and drawing 7 are seen, it turns out that the example 1 is [of a frequency-transmission characteristic and a frequency-VSWR property] both better than the example 1 of a comparison. Although it was also one factor that the mismatching from a characteristic impedance became small since the parasitic capacitance of the reason to which the insertion loss in a passband improved which enters between a vertical joint resonator mold surface acoustic wave filter and a surface acoustic wave resonator decreased, it turned out that another loss factors other than this are also reduced.

[0046]

That is, the frequency-transmission characteristic at the time of removing mismatching loss in simulation (the impedance of all the frequency points having been made in agreement with a characteristic impedance) is shown in drawing 10 from the frequency-transmission characteristic of an example 1 and the example 1 of a comparison.

[0047]

When drawing 10 is seen, even if it removes mismatching loss, the example 1 of an insertion loss is smaller. That is, it can be said that reducing the parasitic

capacitance which enters between a vertical joint resonator mold surface acoustic wave filter and a surface acoustic wave resonator has the effectiveness of reducing not only mismatching loss but another loss factors other than mismatching loss.

[0048]

Next, it investigated concretely into which parasitic capacitance between a vertical joint resonator mold surface acoustic wave filter and a surface acoustic wave resonator should have been made. The approach of examination changed the parasitic capacitance between a vertical joint resonator mold surface acoustic wave filter and a surface acoustic wave resonator to 0.15pF - 0.45pF in simulation, and calculated the value of the insertion loss with which can be satisfied of the pass band width of 75MHz required as a filter for DCS reception.

The result is shown in drawing 33 .

[0049]

It turns out that the insertion loss with which can be satisfied of the pass band width of 75MHz is small, so that the value of the parasitic capacitance between a vertical joint resonator mold surface acoustic wave filter and a surface acoustic wave resonator will become small, if drawing 33 is seen. Generally a commercial-scene demand of the insertion loss of the filter for DCS reception is 2dB in the time of ordinary temperature, and drawing 33 shows that it is necessary to set the value of the parasitic capacitance between a vertical joint resonator mold surface acoustic wave filter and a surface acoustic wave resonator to 0.35pF or less, in order to satisfy this.

[0050]

That is, in the filter for DCS reception whose center frequency is 1842.5 MHz, in order that the parasitic capacitance to 0.35pF may obtain a filter with a good insertion loss, it can be said to be tolerance with close [sufficient] between a vertical joint resonator mold surface acoustic wave filter and a surface acoustic wave resonator.

[0051]

Since the value into which permissible capacity value divided the value of $1842.5 \times 0.35^{**} 6.5 \times 10^2$ by center frequency [MHz] turns into a upper limit of the capacity value which can be generalized and permitted by this to the center frequency to be used, the range of permissible parasitic capacitance can be expressed below as $6.5 \times 10^2/f_0$ [pF] (f_0 is the center frequency [MHz] of the passband of a vertical joint resonator mold surface acoustic wave filter).

[0052]

As a means to reduce the parasitic capacitance which enters between a vertical joint resonator mold surface acoustic wave filter and a surface acoustic wave resonator, not only the abbreviation of 1 ** pad but using each vertical joint resonator mold surface acoustic wave filters 201b and 202b which used the grounding terminal of IDT 206 and 211 as the grounding terminal of other IDT(s) in common with the electrode finger like drawing 2 , and also excluded each electrode pads 302 and 303 further for bump bond like drawing 11 is considered like an example 1. Even in this case, since each grounding terminal of IDT 206 and 211 is as common as the grounding terminal of other IDT(s) through an electrode finger, property sorting in the wafer condition is possible.

[0053]

However, ohmic loss will increase because each ground of IDT 206 and 211 becomes weak, and like the configuration of drawing 11 , if the electrode pads 302 and 303 for bump bond are lost, as shown in drawing 1212 , an insertion loss will get worse further from the example 1 of a comparison. That is, in order to acquire the best insertion loss, it is desirable like drawing 1 to connect only one electrode pad for bump bond or wire bond to each IDT 206 and 211, respectively.

[0054]

As explained above, in order to reduce the parasitic capacitance between a vertical joint resonator mold surface acoustic wave filter and a surface acoustic wave resonator in the surface acoustic wave equipment which gave balanced - unbalance conversion function in the example 1 using two vertical joint resonator

mold surface acoustic wave filters which carried out the series connection of the surface acoustic wave resonator, the insertion loss in a passband and VSWR are improvable by losing 1 ** pad of the grounding terminal of Center IDT. By furthermore communalizing the grounding terminal of Center IDT with the grounding terminal of right and left IDT, even if there is no 1 ** pad of the grounding terminal of Center IDT, property sorting is possible in the state of a wafer.

[0055]

Although the example 1 showed the example of the surface acoustic wave equipment which gave balanced - unbalance conversion function By losing 1 ** pad connected to the grounding terminal of the center IDT of a vertical joint resonator mold surface acoustic wave filter like drawing 14 also in the surface acoustic wave equipment which does not have balanced - unbalance conversion function like drawing 13 The parasitic capacitance between a vertical joint resonator mold surface acoustic wave filter and a surface acoustic wave resonator can decrease, and the surface acoustic wave equipment which the insertion loss in a passband has improved can be obtained.

[0056]

moreover, as another example of the surface acoustic wave equipment which gave balanced - unbalance conversion function Also in the surface acoustic wave equipment of a configuration of connecting right and left IDT to reverse, and connecting an unbalance signal terminal and Center IDT to a balanced signal terminal in an example 1, like drawing 15 By losing 1 ** pad connected to the grounding terminal of the center IDT of a vertical joint resonator mold surface acoustic wave filter like drawing 16 The parasitic capacitance between a vertical joint resonator mold surface acoustic wave filter and a surface acoustic wave resonator can decrease, and the surface acoustic wave equipment which has improved the insertion loss in a passband can be obtained.

[0057]

Moreover, it also sets to the surface acoustic wave equipment of a configuration

of having balanced - unbalance conversion function like drawing 17 using one vertical joint resonator mold surface acoustic wave filter by dividing the center IDT into two along the propagation direction of a surface acoustic wave. By losing 1 ** pad connected to the grounding terminal of the center IDT of a vertical joint resonator mold surface acoustic wave filter like drawing 18 The parasitic capacitance between a vertical joint resonator mold surface acoustic wave filter and a surface acoustic wave resonator can decrease, and the surface acoustic wave equipment which has improved the insertion loss in a passband can be obtained.

[0058]

Moreover, although surface acoustic wave equipment was produced like drawing 5 in the example 1 by the approach of taking a flow with a package 400 and each electrode pad on the piezo-electric substrate 301 by the face down method of construction using the bump bond method, it is satisfactory even if this is a wire bond method of construction.

[0059]

Moreover, join the piezo-electric substrate 1002 by the flip chip method of construction on the set substrate 1001 not only like the configuration of drawing 5 but like drawing 19 as a configuration produced by the face down method of construction, and resin 1003 is covered and closed on it. As shown in the configuration cut per 1 package by dicing, and drawing 2020 , similarly join the piezo-electric substrate 1102 by the flip chip method of construction on the set substrate 1101, and the sheet-like resin material 1103 is covered and closed on it. Surface acoustic wave equipment may be produced with the configuration cut per 1 package by dicing.

[0060]

Furthermore, although the piezo-electric substrate 301 which consists of 40 **5-degreeYcutX propagation LiTaO₃ was used in the example 1, as for this invention, the same effectiveness is acquired not only with this piezo-electric substrate 301 but with piezo-electric substrates, such as the 64 degrees - 72

degreeYcutX propagation LiNbO₃ and the 41-degreeYcutX propagation LiNbO₃, as the principle from which effectiveness is acquired also shows.

[0061]

(Example 2)

The configuration of the example 2 of this invention is explained using drawing 21 and drawing 22 . First, the electrode configuration of an example 2 is explained using drawing 21 . In the example 2, the surface acoustic wave resonator 1202 connected with the vertical joint resonator mold surface acoustic wave filter 1201 and the vertical joint resonator mold surface acoustic wave filter 1201 to them at the serial is formed with aluminum electrode on the piezo-electric substrate 301 which consists of 40 **5-degreeYcutX propagation LiTaO₃.

[0062]

In the configuration of the vertical joint resonator mold surface acoustic wave filter 1201, each reflectors 1208 and 1209 are formed, respectively so that each IDT 1203-1207 arranged along the propagation direction of a surface acoustic wave may be put. The pitch of the electrode finger of the part where two IDT(s) adjoin each other is made smaller than other parts of IDT so that it may turn out that drawing 21 is seen (part of 1210-1213 of drawing 21).

[0063]

Each IDT 1204 and 1206 is connected to the unbalance signal terminal 1214 for each IDT 1203, 1205, and 1207 through the surface acoustic wave resonator 1202 again at the balanced signal terminals 1215 and 1216, respectively. At this time, phase inversion of IDT1206 is carried out to IDT1204, and this is giving balanced - unbalance conversion function.

[0064]

Each reflectors 1218 and 1219 are formed so that the configuration of the surface acoustic wave resonator 1202 may put IDT1217. The actual layout on the piezo-electric substrate 301 in an example 2 is shown in drawing 22 . In drawing 22 , the part corresponding to drawing 21 is shown using the same member number.

[0065]

With the layout shown by drawing 22 , the rectangular head of the electrode pad for bump bond for a slanting grid-like rectangular head to take a package and a flow and a slash is 1 ** pad. the description of an example 2 -- drawing 22 -- setting -- every -- every arranged among each leading about 1304, 1305, and 1306 which has connected IDT 1203, 1205, and 1207 and IDT1217, respectively -- it is only the electrode pads 1302 and 1303 for bump bond being connected to the grounding terminal of IDT 1204 and 1206, respectively, and there being no 1 ** pad, that is, excluded.

[0066]

In connection with it, the grounding terminal of IDT1206 and the grounding terminal of IDT1207 are communalized [in / in the grounding terminal of IDT1204, and the grounding terminal of IDT1203 / the part (part which adjoins each other mutually) of 1221] in drawing 21 in the part (part which adjoins each other mutually) of 1220 using the electrode finger. Thereby, even if it does not connect 1 ** pad to each grounding terminal of IDT 1204 and 1206, a filter shape can be checked in the state of a wafer, and property sorting can be performed.

[0067]

If the detailed design of the vertical joint resonator mold surface acoustic wave filter 1201 sets to lambdal wavelength decided by the pitch of the electrode finger which has not made the pitch small,

Decussation width of face: 37.1lambdal

IDT number (order of 1,203, 1204, 1205, 1206, and 1207): -- (3)2222(3) / (3)31(3) / (3)37(3) / (3)31(3) (number of the electrode finger with which the inside of a parenthesis made the pitch small)

Reflector number: 60

duty: -- 0.72 (IDT) and 0.57 (reflector)

Electrode-layer thickness: 0.092lambdal

The detailed design of the surface acoustic wave resonator 1202 is as follows.

Decussation width of face: 50.7lambdal

IDT number: 250

Reflector number: 30

duty:0.60

Electrode-layer thickness: 0.093lambda

Next, the operation and effectiveness about the configuration of this example 2 are explained. The frequency-transmission characteristic of the configuration of an example 2 and a frequency-VSWR property are shown in drawing 23 and drawing 24 , respectively. As a comparison, moreover the configuration of the example 2 of a comparison is shown in drawing 25 and drawing 26 , the frequency-transmission characteristic of the example 2 of a comparison and a frequency-VSWR property are shown in them according to drawing 23 and drawing 24 , respectively.

[0068]

the configuration of the example 2 of a comparison -- an example 2 -- receiving -- every -- the grounding terminal of IDT 1204 and 1206 -- 1 ** pad -- preparing -- further -- every -- every between IDT1203 and 1204 -- the grounding terminal between IDT1206 and 1207 is separated mutually. All the other design parameters etc. are the same.

[0069]

When drawing 23 and drawing 24 are seen, it turns out that the example 2 is [of a frequency-transmission characteristic and a frequency-VSWR property] both better than the example 2 of a comparison. Moreover, the frequency-transmission characteristic at the time of removing mismatching loss in simulation is shown in drawing 27 from the frequency-transmission characteristic of an example 2 and the example 2 of a comparison. When drawing 27 is seen, it turns out that the insertion loss of the example 2 is smaller than the example 2 of a comparison.

[0070]

That is, by reducing the parasitic capacitance between a vertical joint resonator mold surface acoustic wave filter and a surface acoustic wave resonator like an

example 1, when five IDT(s) are used like an example 2, not only mismatching loss but another loss factor is reduced, and surface acoustic wave equipment with the good insertion loss in a passband is obtained.

[0071]

As explained above, in the surface acoustic wave equipment which gave balanced - unbalance conversion function using the vertical joint resonator mold surface acoustic wave filter which carried out the series connection of the surface acoustic wave resonator, and which has five IDT(s), the insertion loss in a passband and VSWR are improvable with an example 2 by reducing the parasitic capacitance between a vertical joint resonator mold surface acoustic wave filter and a surface acoustic wave resonator.

[0072]

Although the example 2 showed the example which connects each IDT 1204 and 1206 in drawing 21 to a balanced signal terminal, and has balanced - unbalance conversion function For example, divide into two IDT1303 located in the center along the propagation direction of a surface acoustic wave like drawing 28 , and each IDT 1301, 1303, and 1305 is also set in the configuration linked to a balanced signal terminal. By losing 1 ** pad connected to the grounding terminal of IDT1303 like drawing 29 , the parasitic capacitance between a vertical joint resonator mold surface acoustic wave filter and a surface acoustic wave resonator can decrease, and the surface acoustic wave equipment which the insertion loss in a passband has improved can be obtained.

[0073]

(Example 3)

The example 3 of this invention is shown in drawing 30 . In addition to the configuration shown in the example 1 in the example 3, it sets to the bus bar of every IDT205c, and 206c, 207c, 210c, 211c and 212c. A signal electrode and a ground electrode adjoin each other mutually. Each vertical joint resonator mold surface acoustic wave filter 201c, In the part (drawing 30 1501-1504) where parasitic capacitance enters between 202c and each surface acoustic wave

resonators 203 and 204 (it generates), the bus bar is set up so that it may become thinner than other parts.

[0074]

In other words, it is set up so that spacing which the signal electrode and ground electrode in the bus bar of every IDT205c, and 206c, 207c, 210c, 211c and 212c adjoin mutually, and adjoin the account of a top in each corner of the side near each surface acoustic wave resonators 203 and 204 may become large toward the method of outside one by one (outwardness which intersects perpendicularly to the propagation direction of a surface acoustic wave). As for the width of face which a bus bar is thin and was set up, at this time, it is desirable that it is larger than the width of face of the electrode finger connected with it. Moreover, it is more desirable to extend in the shape of a curve from a strong point and the strong ease of manufacturing, although the way of spreading may be linear or it may be rounded.

[0075]

Next, an operation and effectiveness of this example 3 are explained. In the configuration of drawing 30 , the parasitic capacitance between a vertical joint resonator mold surface acoustic wave filter and a surface acoustic wave resonator is further reduced rather than an example 1, and the surface acoustic wave equipment with which the insertion loss in a passband has been improved further is obtained.

[0076]

(Example 4)

With the surface acoustic wave equipment concerning the example 4 of this invention As shown in drawing 31 , in the configuration shown in the example 1 in addition, between each leading about 304-307 which has connected the vertical joint resonator mold surface acoustic wave filter and the surface acoustic wave resonator and each electrode pads 302 and 303 for the Bengbu pads, and the piezo-electric substrate 301 Each insulating layers 1401 and 1402 with specific inductive capacity smaller than the piezo-electric substrate 301 are formed in

each field across which it faced between the vertical joint resonator mold surface acoustic wave filters 201 and 202 and the surface acoustic wave resonators 203 and 204, respectively.

[0077]

That is, in this example 4, are arranged at the side to which the surface acoustic wave resonators 203 and 204 are connected. The earth line which has connected the electrode pad 302,303 connected to the grounding terminal of IDT, and the grounding terminal and electrode pad of IDT, And each above-mentioned insulating layers 1401 and 1402 are formed between at least one and the piezo-electric substrates 301 of each signal lines 304-307 which have connected the vertical joint resonator mold surface acoustic wave filters 201 and 202 and the surface acoustic wave resonators 203 and 204.

[0078]

While shows the sectional view of a part to drawing 32 in said each field. An insulating layer 1402 is formed on the piezo-electric substrate 301, and each leading about 306 and 307 and the electrode pad 303 are formed on the insulating layer 1402. As each insulating layers 1401 and 1402, photopolymers, such as photosensitive polyimide, SiO₂, SiN, etc. are mentioned.

[0079]

Next, an operation and effectiveness of this example 4 are explained. Like drawing 31 , if each insulating layers 1401 and 1402 are formed between the piezo-electric substrate 301 and each leading about 304-307, since specific inductive capacity is smaller than the piezo-electric substrate 301, insulating layers 1401 and 1402 can reduce the parasitic capacitance which enters between the vertical joint resonator mold surface acoustic wave filters 201 and 202 and the surface acoustic wave resonators 203 and 204 based on the formula of the capacity value of the capacitor mentioned above. Thereby, in this example 4, the surface acoustic wave equipment which has improved the insertion loss in a passband further from the aforementioned example 1 is obtained.

[0080]

In addition, in each above-mentioned example 1 thru/or 4, although the operation and effectiveness by each configuration were explained, these examples 1 thru/or 4 may be combined how.

[0081]

(Example 5)

Next, the communication device using surface acoustic wave equipment given in the above-mentioned example 1 thru/or any of 4 they are is explained based on drawing 34 . [concerning this invention] As shown in drawing 34 , as a receiver side (Rx side) which receives, the above-mentioned communication device 600 is equipped with an antenna 601, the antenna common section / RFTop filter 602, amplifier 603, Rx interstage filter 604, a mixer 605, the 1stIF filter 606, a mixer 607, the 2ndIF filter 608, the 1st+2nd local synthesizer 611, TCXO (temperature compensated crystal oscillator (temperature-compensated crystal oscillator))612, a divider 613, and the local filter 614, and is constituted.

[0082]

As double lines showed, in order to secure balance nature from Rx interstage filter 604 to drawing 34 to a mixer 605, transmitting by each balanced signal is desirable.

[0083]

Moreover, as a transceiver side (Tx side) which transmits, it has the TxIF filter 621, a mixer 622, Tx interstage filter 623, amplifier 624, a coupler 625, an isolator 626, and APC (automatic power control)627 (APC), and the above-mentioned communication device 600 is constituted while sharing the above-mentioned antenna 601, and the above-mentioned above-mentioned antenna common section / RFTop filter 602.

[0084]

And the surface acoustic wave equipment which the publication for this example 1 thru/or any of 4 their being or they combined can use for the above-mentioned Rx interstage filter 604, the 1stIF filter 606, the TxIF filter 621, Tx interstage filter 623, and the antenna common section / RFTop filter 602 suitably. [which was

mentioned above]

[0085]

The surface acoustic wave equipment concerning this invention is equipped with an unbalance-balance conversion function with a filtering function, and, moreover, has the outstanding property that an insertion loss is small. Therefore, by having used the above-mentioned surface acoustic wave equipment which has the outstanding transmission characteristic, the communication device of this invention which has the above-mentioned surface acoustic wave equipment can be improving the communication link property while being able to miniaturize.

[0086]

[Effect of the Invention]

The vertical joint resonator mold surface acoustic wave filter which has at least three IDT(s) by which this invention was formed along the propagation direction of a surface acoustic wave on the piezo-electric substrate as explained above, It has at least one surface acoustic wave resonator connected to said vertical joint resonator mold surface acoustic wave filter at the serial. To said surface acoustic wave resonator In the surface acoustic wave equipment to which at least two IDT(s) are connected among two or more IDT(s) of said vertical joint resonator mold surface acoustic wave filter It is the configuration of having set the value of the parasitic capacitance which enters between said vertical joint resonator mold surface acoustic wave filters and surface acoustic wave resonators to $6.5 \times 10^2 / \text{below } f_0$ [pF] (however, center frequency of a passband [in / in f_0 / a vertical joint resonator mold surface acoustic wave filter] [MHz]).

[0087]

So, by setting out of the above-mentioned parasitic capacitance, band interpolation close loss improves and the above-mentioned configuration does the effectiveness that VSWR can obtain good surface acoustic wave equipment.

[Brief Description of the Drawings]

[Drawing 1] It is the outline top view showing the layout on the piezo-electric substrate in the surface acoustic wave equipment of an example 1 concerning

this invention.

[Drawing 2] It is the block diagram of the surface acoustic wave equipment of the above-mentioned example 1.

[Drawing 3] It is the block diagram of conventional surface acoustic wave equipment.

[Drawing 4] It is the outline top view showing the layout on the piezo-electric substrate in the above-mentioned conventional surface acoustic wave equipment.

[Drawing 5] It is the sectional view of the surface acoustic wave equipment of the above-mentioned example 1.

[Drawing 6] It is the graph which shows the frequency-transmission characteristic of the above-mentioned example 1 and the example 1 of a comparison, respectively.

[Drawing 7] It is the graph which shows the frequency-VSWR property of the above-mentioned example 1 and the example 1 of a comparison, respectively, and (a) is (b) at the time of S22 at the time of S11.

[Drawing 8] It is the block diagram of the surface acoustic wave equipment of the above-mentioned example 1 of a comparison.

[Drawing 9] It is the outline top view showing the layout on the piezo-electric substrate of the above-mentioned example 1 of a comparison.

[Drawing 10] It is the graph which shows the frequency-transmission characteristic at the time of removing the mismatching loss of the above-mentioned example 1 and the example 1 of a comparison, respectively.

[Drawing 11] It is the outline top view showing the layout on a piezo-electric substrate when excluding the electrode pad for bump bond between a vertical joint resonator mold surface acoustic wave filter and a surface acoustic wave resonator from the above-mentioned example 1.

[Drawing 12] It is the graph which shows the frequency-transmission characteristic of drawing 11 and the example 1 of a comparison, respectively.

[Drawing 13] It is the block diagram of the example of a complete-change form in the surface acoustic wave equipment of the above-mentioned example 1.

[Drawing 14] It is the outline top view showing the layout on a piezo-electric substrate of the surface acoustic wave equipment shown in above-mentioned drawing 13 .

[Drawing 15] It is the block diagram of other modifications in the surface acoustic wave equipment of the above-mentioned example 1.

[Drawing 16] It is the outline top view showing the layout on a piezo-electric substrate of the surface acoustic wave equipment shown in above-mentioned drawing 15 .

[Drawing 17] It is the block diagram of the modification of others [pan / in the surface acoustic wave equipment of the above-mentioned example 1].

[Drawing 18] It is the outline top view showing the layout on a piezo-electric substrate of the surface acoustic wave equipment shown in above-mentioned drawing 17 .

[Drawing 19] It is the sectional view showing the 1 manufacture process of the surface acoustic wave equipment of the above-mentioned example 1.

[Drawing 20] It is the sectional view showing other 1 manufacture processes of the surface acoustic wave equipment of the above-mentioned example 1.

[Drawing 21] It is the block diagram of the surface acoustic wave equipment of an example 2 concerning this invention.

[Drawing 22] It is the outline top view in the surface acoustic wave equipment of the above-mentioned example 2 showing the layout on a piezo-electric substrate.

[Drawing 23] It is the graph which shows the frequency-transmission characteristic of the above-mentioned example 2 and the example 2 of a comparison, respectively.

[Drawing 24] It is the graph which shows the frequency-VSWR property of the above-mentioned example 2 and the example 2 of a comparison, respectively, and (a) is (b) at the time of S22 at the time of S11.

[Drawing 25] It is the block diagram of the surface acoustic wave equipment of the above-mentioned example 2 of a comparison.

[Drawing 26] It is the outline top view in the surface acoustic wave equipment of

the above-mentioned example 2 of a comparison showing the layout on a piezo-electric substrate.

[Drawing 27] It is the graph which shows the frequency-transmission characteristic which removed the mismatching loss of the above-mentioned example 2 and the example 2 of a comparison, respectively.

[Drawing 28] It is the block diagram of the example of a complete-change form in the surface acoustic wave equipment of the above-mentioned example 2.

[Drawing 29] It is the outline top view in the surface acoustic wave equipment shown in above-mentioned drawing 28 showing the layout on a piezo-electric substrate.

[Drawing 30] It is the block diagram of the surface acoustic wave equipment of an example 3 concerning this invention.

[Drawing 31] It is an outline top view in the surface acoustic wave equipment of an example 4 concerning this invention.

[Drawing 32] It is the sectional view of the part in which the insulating layer of the above-mentioned example 4 was prepared.

[Drawing 33] It is a graph in the surface acoustic wave equipment concerning this invention to show the value of standard of parasitic capacitance, and is the graph which shows change of the insertion loss over change of the parasitic capacitance in each surface acoustic wave equipment of this invention and the example of a comparison.

[Drawing 34] It is the important section block diagram of the communication device using the surface acoustic wave equipment of this invention.

[Description of Notations]

201 Vertical Joint Resonator Mold Surface Acoustic Wave Filter

203 Surface Acoustic Wave Resonator

205, 206, 207 IDT (comb mold polar zone)

301 Piezo-electric Substrate

[Translation done.]

*** NOTICES ***

JPO and NCIPI are not responsible for any damages caused by the use of this translation.

1. This document has been translated by computer. So the translation may not reflect the original precisely.
2. **** shows the word which can not be translated.
3. In the drawings, any words are not translated.

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]

[Drawing 1] It is the outline top view showing the layout on the piezo-electric substrate in the surface acoustic wave equipment of an example 1 concerning this invention.

[Drawing 2] It is the block diagram of the surface acoustic wave equipment of the above-mentioned example 1.

[Drawing 3] It is the block diagram of conventional surface acoustic wave equipment.

[Drawing 4] It is the outline top view showing the layout on the piezo-electric substrate in the above-mentioned conventional surface acoustic wave equipment.

[Drawing 5] It is the sectional view of the surface acoustic wave equipment of the above-mentioned example 1.

[Drawing 6] It is the graph which shows the frequency-transmission characteristic of the above-mentioned example 1 and the example 1 of a comparison, respectively.

[Drawing 7] It is the graph which shows the frequency-VSWR property of the above-mentioned example 1 and the example 1 of a comparison, respectively, and (a) is (b) at the time of S22 at the time of S11.

[Drawing 8] It is the block diagram of the surface acoustic wave equipment of the

above-mentioned example 1 of a comparison.

[Drawing 9] It is the outline top view showing the layout on the piezo-electric substrate of the above-mentioned example 1 of a comparison.

[Drawing 10] It is the graph which shows the frequency-transmission characteristic at the time of removing the mismatching loss of the above-mentioned example 1 and the example 1 of a comparison, respectively.

[Drawing 11] It is the outline top view showing the layout on a piezo-electric substrate when excluding the electrode pad for bump bond between a vertical joint resonator mold surface acoustic wave filter and a surface acoustic wave resonator from the above-mentioned example 1.

[Drawing 12] It is the graph which shows the frequency-transmission characteristic of drawing 11 and the example 1 of a comparison, respectively.

[Drawing 13] It is the block diagram of the example of a complete-change form in the surface acoustic wave equipment of the above-mentioned example 1.

[Drawing 14] It is the outline top view showing the layout on a piezo-electric substrate of the surface acoustic wave equipment shown in above-mentioned drawing 13 .

[Drawing 15] It is the block diagram of other modifications in the surface acoustic wave equipment of the above-mentioned example 1.

[Drawing 16] It is the outline top view showing the layout on a piezo-electric substrate of the surface acoustic wave equipment shown in above-mentioned drawing 15 .

[Drawing 17] It is the block diagram of the modification of others [pan / in the surface acoustic wave equipment of the above-mentioned example 1].

[Drawing 18] It is the outline top view showing the layout on a piezo-electric substrate of the surface acoustic wave equipment shown in above-mentioned drawing 17 .

[Drawing 19] It is the sectional view showing the 1 manufacture process of the surface acoustic wave equipment of the above-mentioned example 1.

[Drawing 20] It is the sectional view showing other 1 manufacture processes of

the surface acoustic wave equipment of the above-mentioned example 1.

[Drawing 21] It is the block diagram of the surface acoustic wave equipment of an example 2 concerning this invention.

[Drawing 22] It is the outline top view in the surface acoustic wave equipment of the above-mentioned example 2 showing the layout on a piezo-electric substrate.

[Drawing 23] It is the graph which shows the frequency-transmission characteristic of the above-mentioned example 2 and the example 2 of a comparison, respectively.

[Drawing 24] It is the graph which shows the frequency-VSWR property of the above-mentioned example 2 and the example 2 of a comparison, respectively, and (a) is (b) at the time of S22 at the time of S11.

[Drawing 25] It is the block diagram of the surface acoustic wave equipment of the above-mentioned example 2 of a comparison.

[Drawing 26] It is the outline top view in the surface acoustic wave equipment of the above-mentioned example 2 of a comparison showing the layout on a piezo-electric substrate.

[Drawing 27] It is the graph which shows the frequency-transmission characteristic which removed the mismatching loss of the above-mentioned example 2 and the example 2 of a comparison, respectively.

[Drawing 28] It is the block diagram of the example of a complete-change form in the surface acoustic wave equipment of the above-mentioned example 2.

[Drawing 29] It is the outline top view in the surface acoustic wave equipment shown in above-mentioned drawing 28 showing the layout on a piezo-electric substrate.

[Drawing 30] It is the block diagram of the surface acoustic wave equipment of an example 3 concerning this invention.

[Drawing 31] It is an outline top view in the surface acoustic wave equipment of an example 4 concerning this invention.

[Drawing 32] It is the sectional view of the part in which the insulating layer of the above-mentioned example 4 was prepared.

[Drawing 33] It is a graph in the surface acoustic wave equipment concerning this invention to show the value of standard of parasitic capacitance, and is the graph which shows change of the insertion loss over change of the parasitic capacitance in each surface acoustic wave equipment of this invention and the example of a comparison.

[Drawing 34] It is the important section block diagram of the communication device using the surface acoustic wave equipment of this invention.

[Description of Notations]

201 Vertical Joint Resonator Mold Surface Acoustic Wave Filter

203 Surface Acoustic Wave Resonator

205, 206, 207 IDT (comb mold polar zone)

301 Piezo-electric Substrate

[Translation done.]

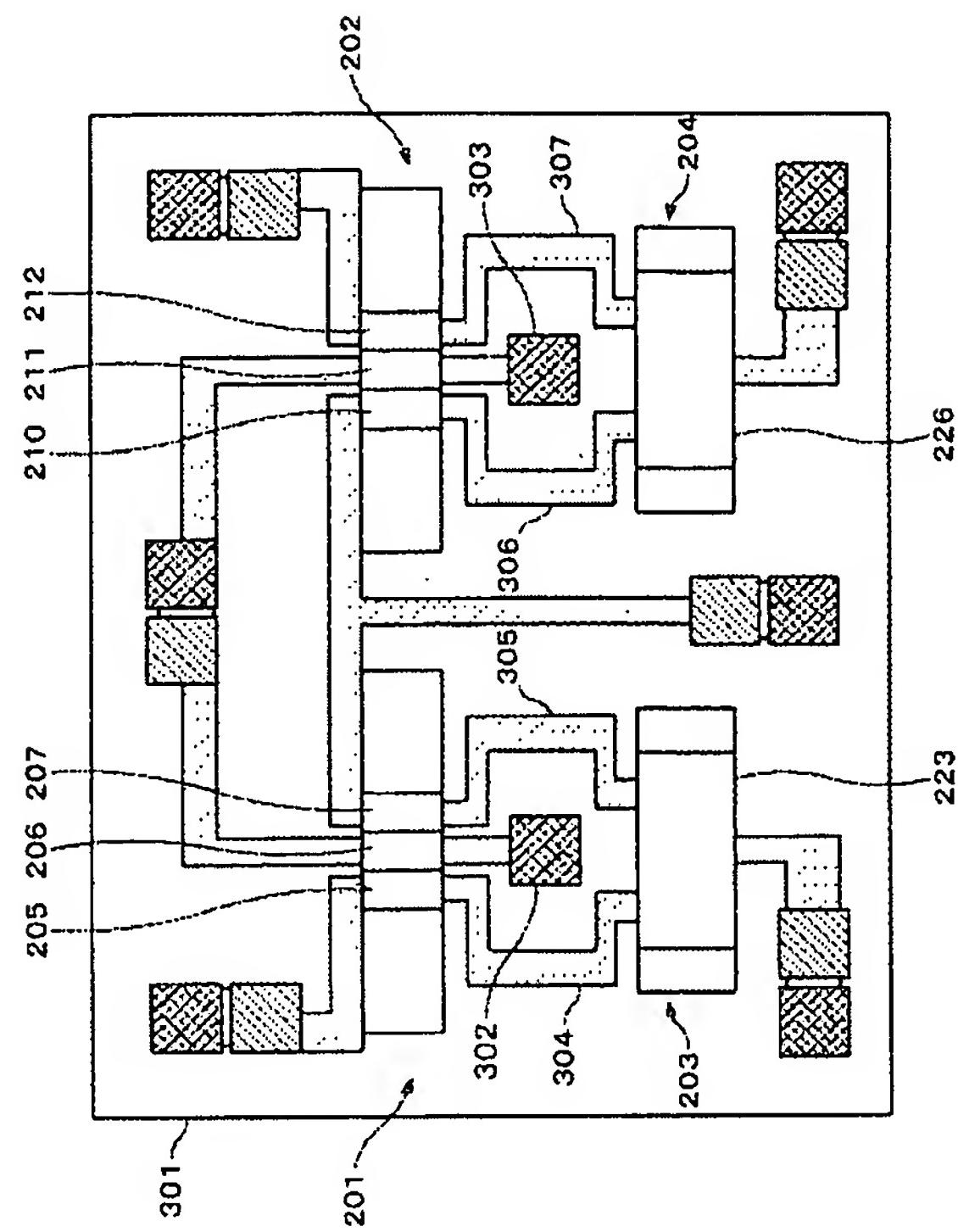
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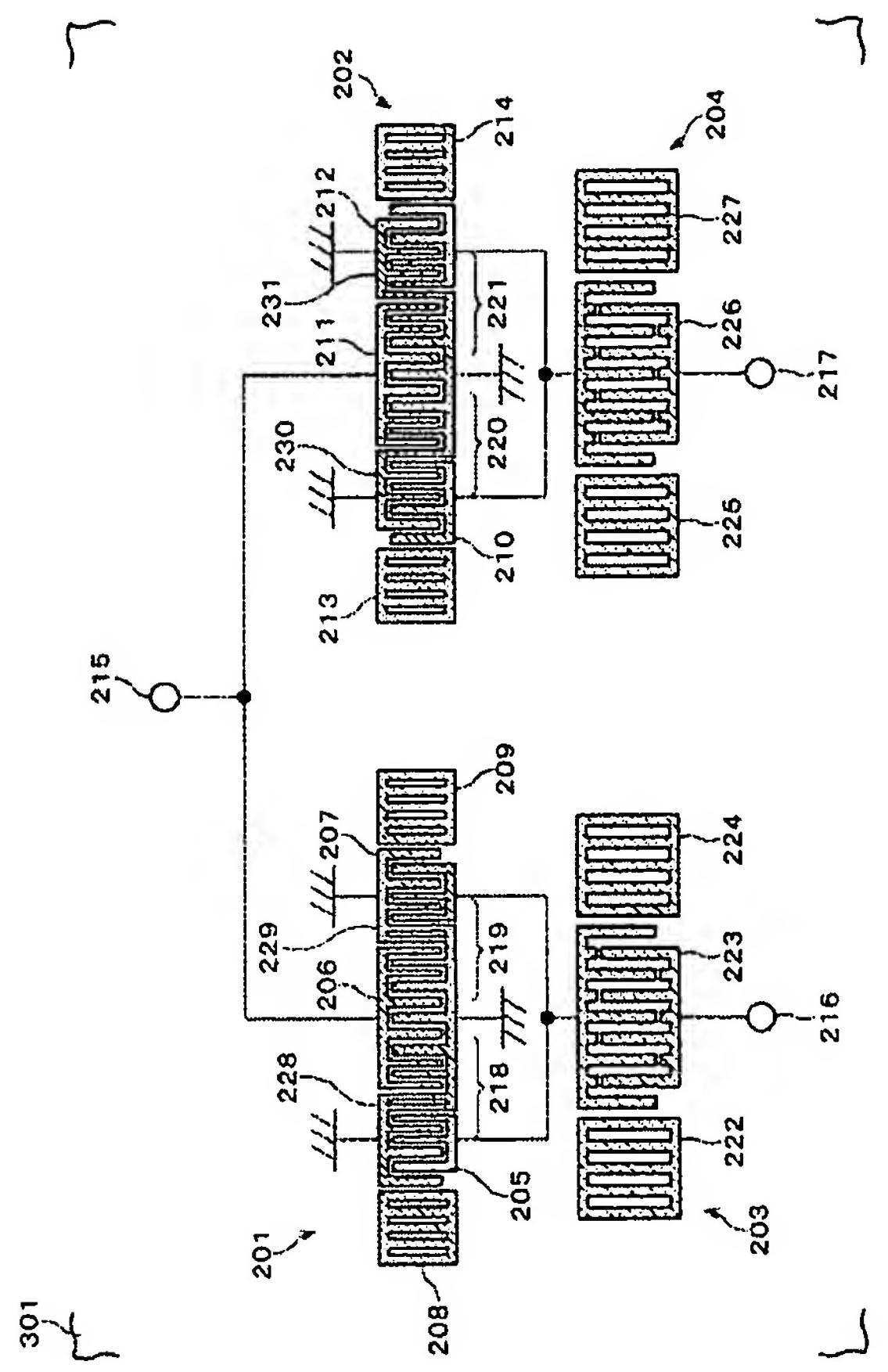
1. This document has been translated by computer. So the translation may not reflect the original precisely.
2. **** shows the word which can not be translated.
3. In the drawings, any words are not translated.

DRAWINGS

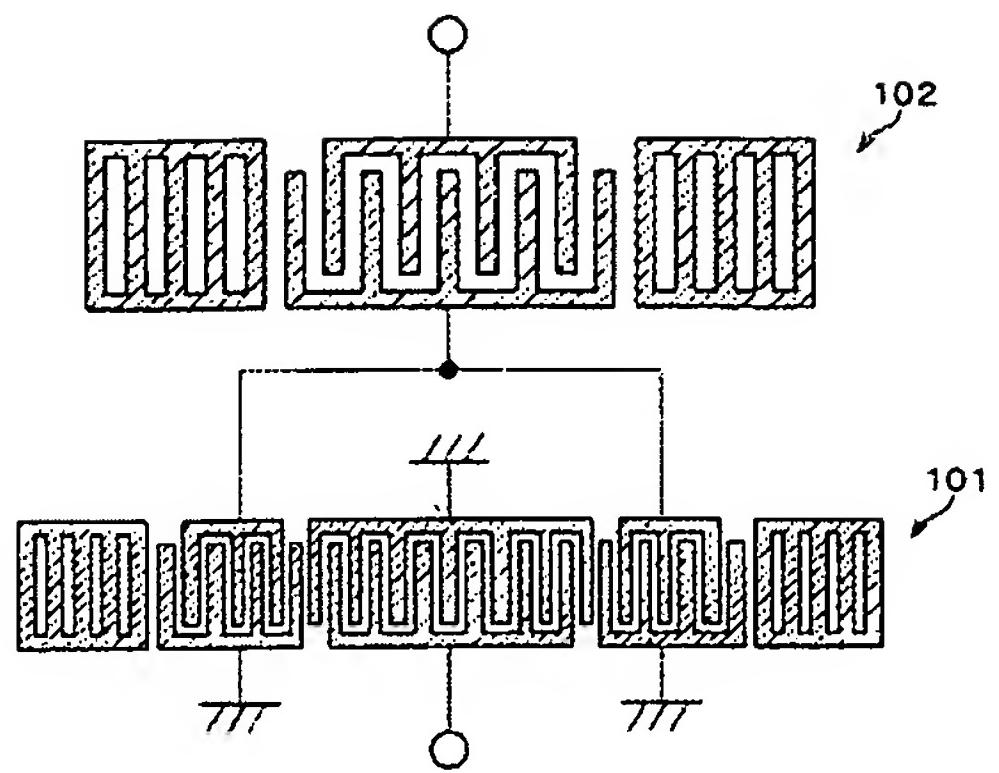
[Drawing 1]



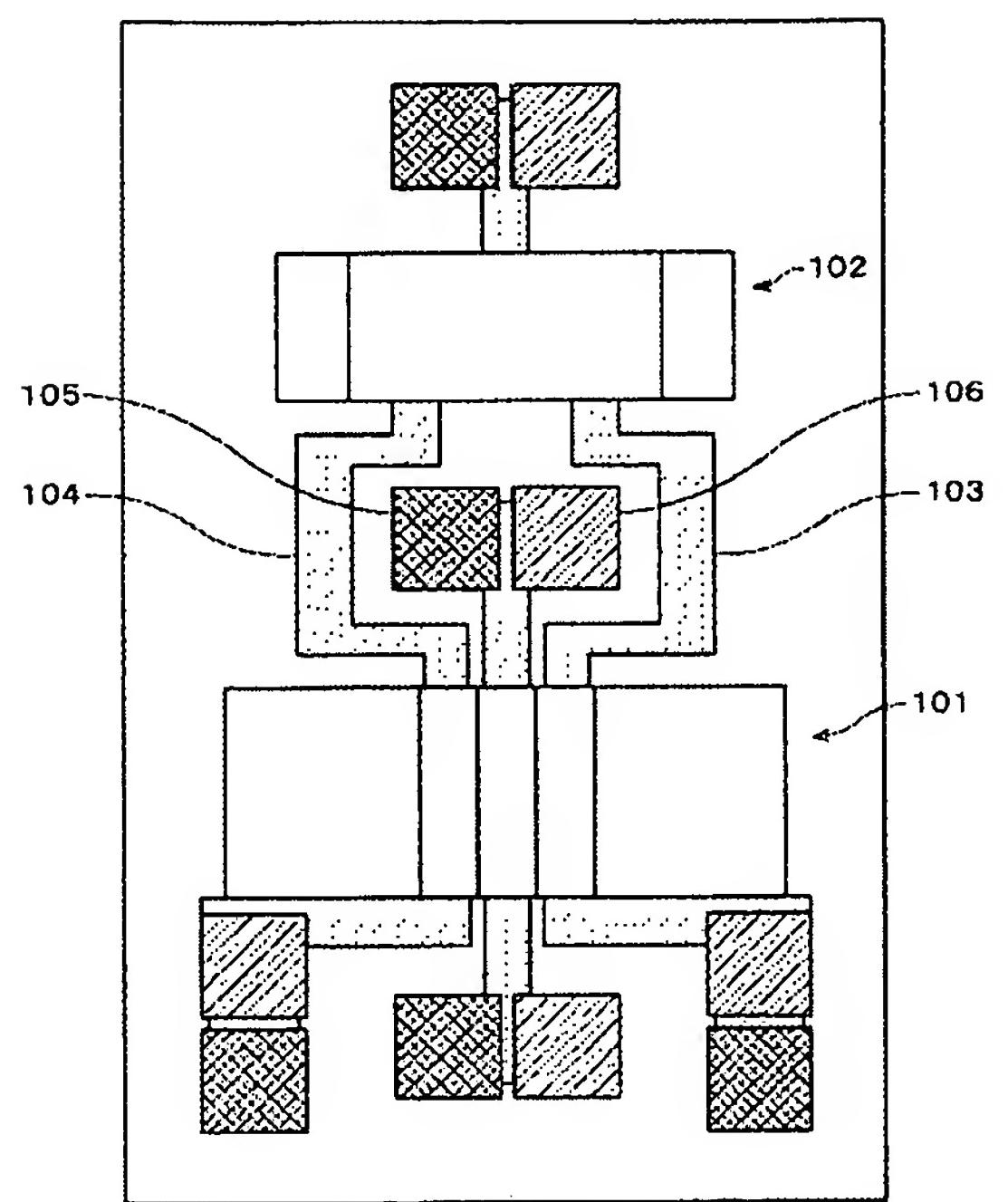
[Drawing 2]



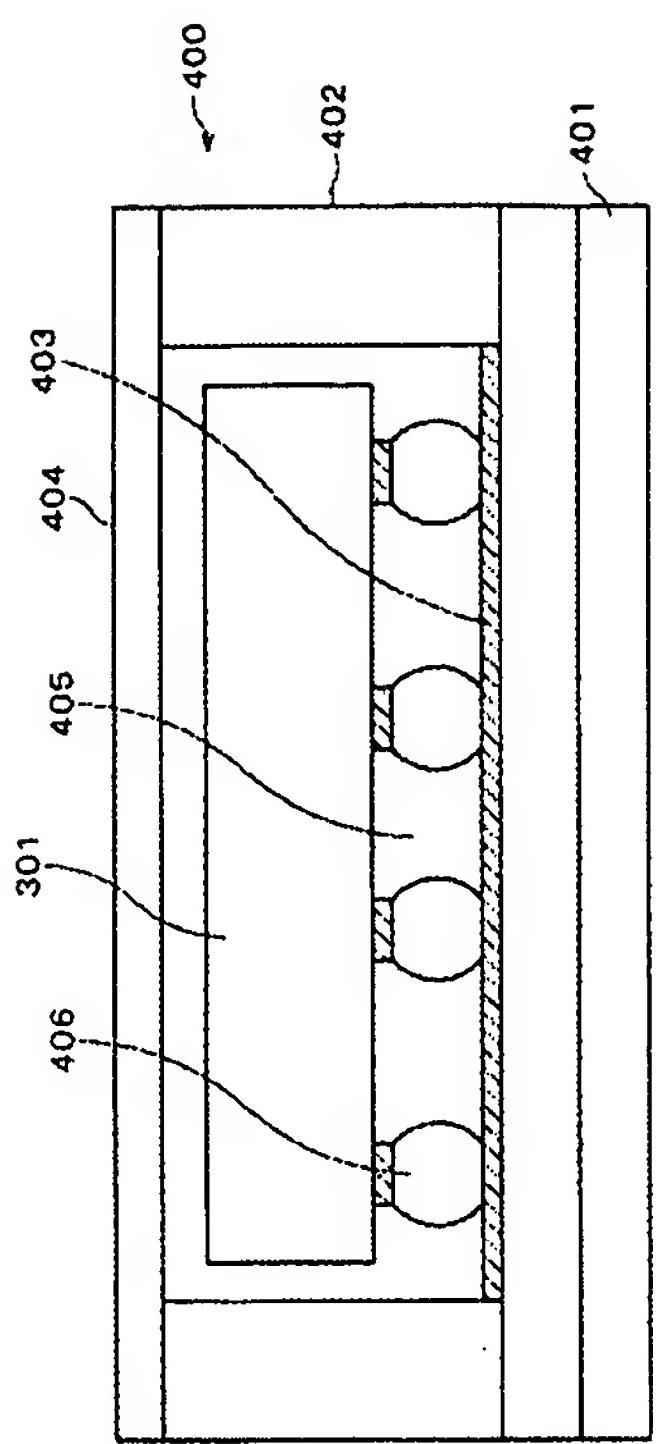
[Drawing 3]



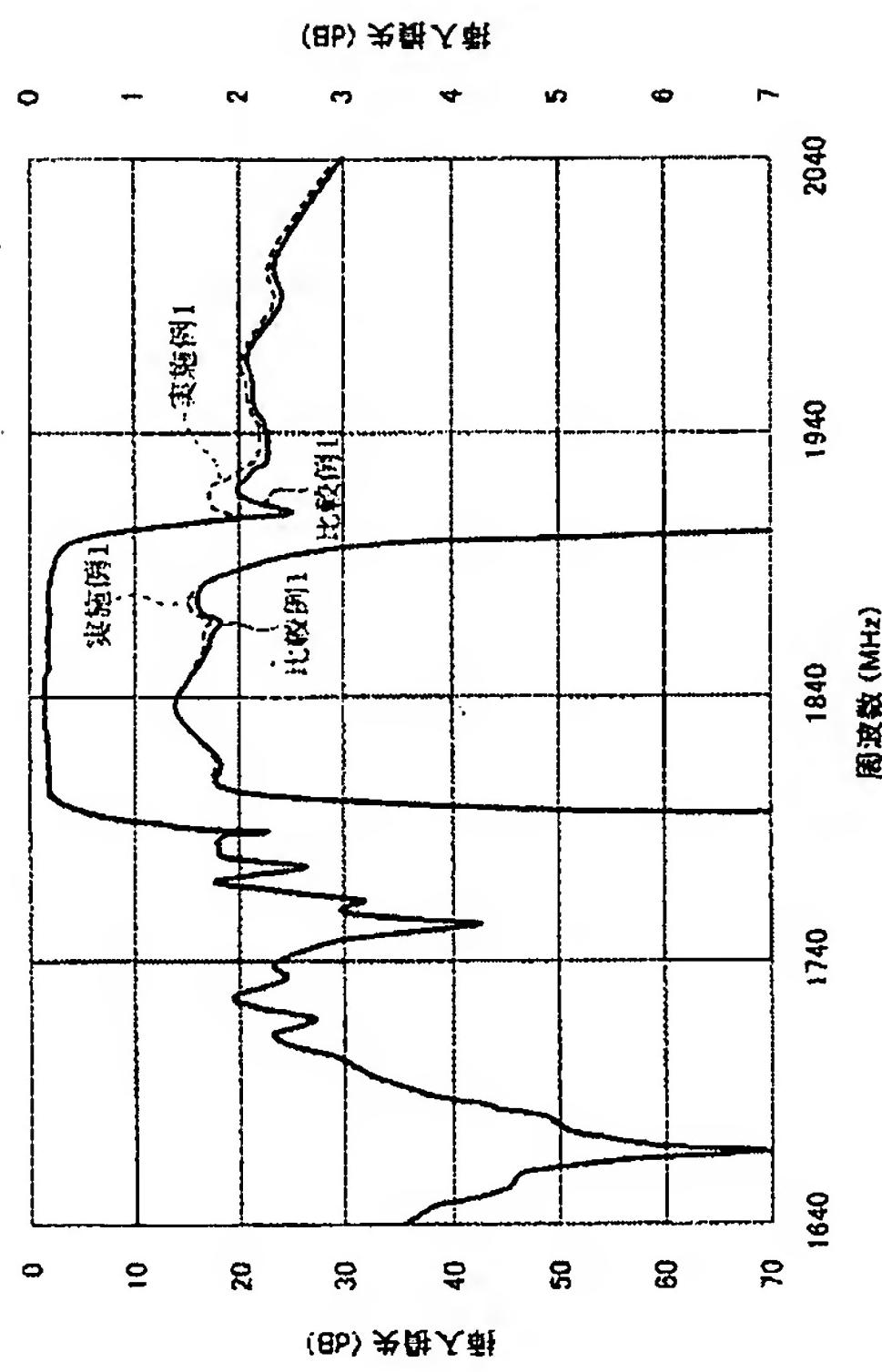
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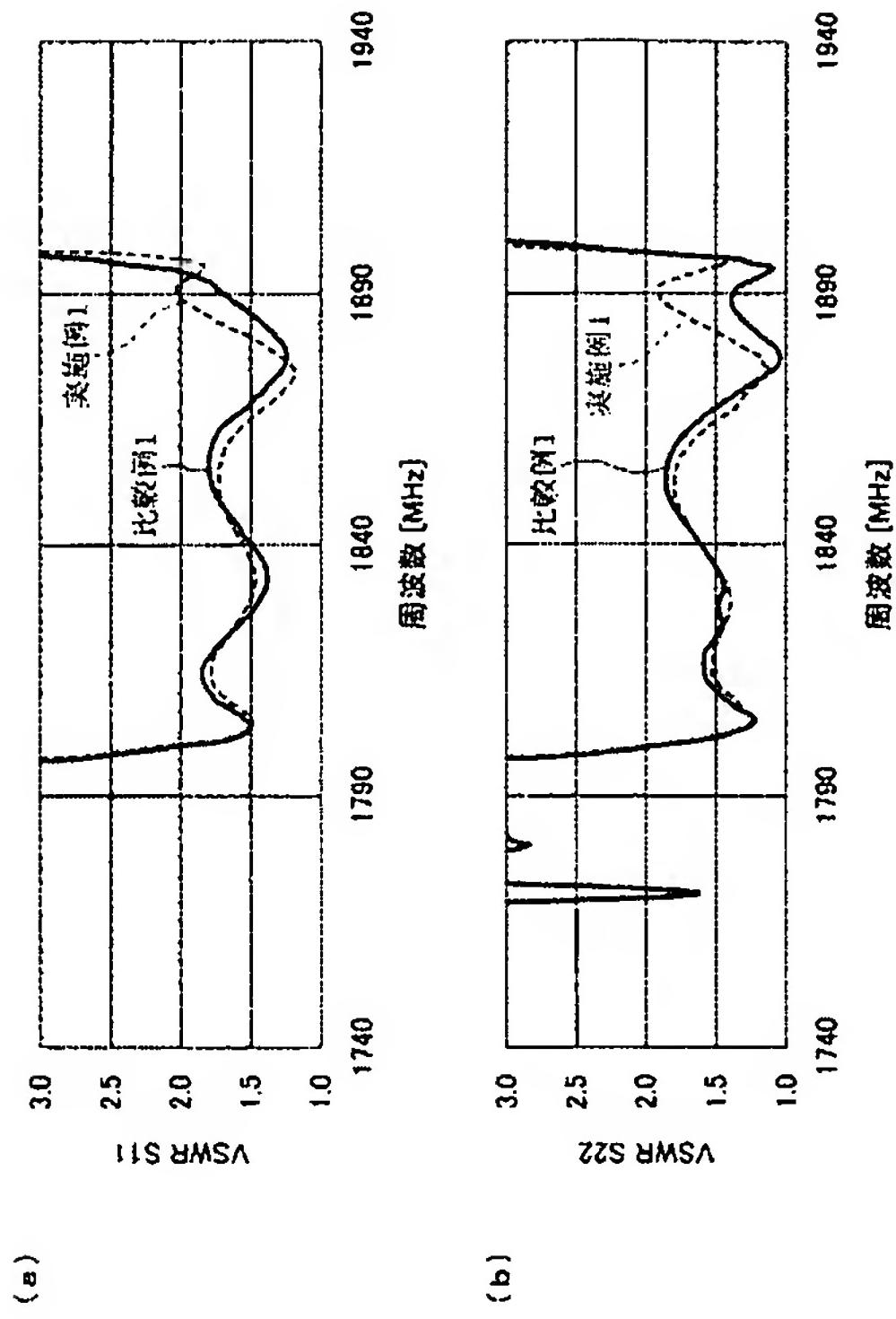
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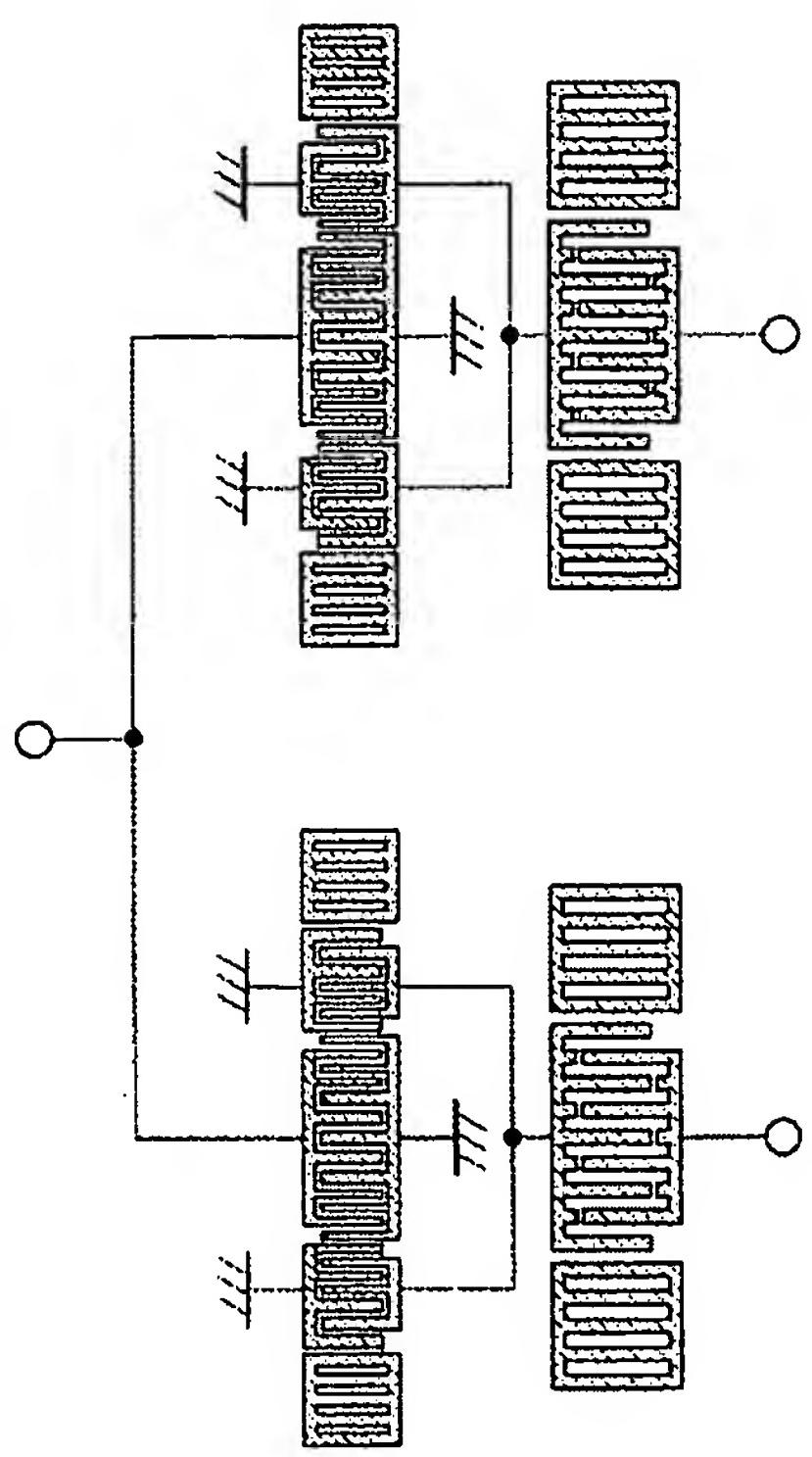
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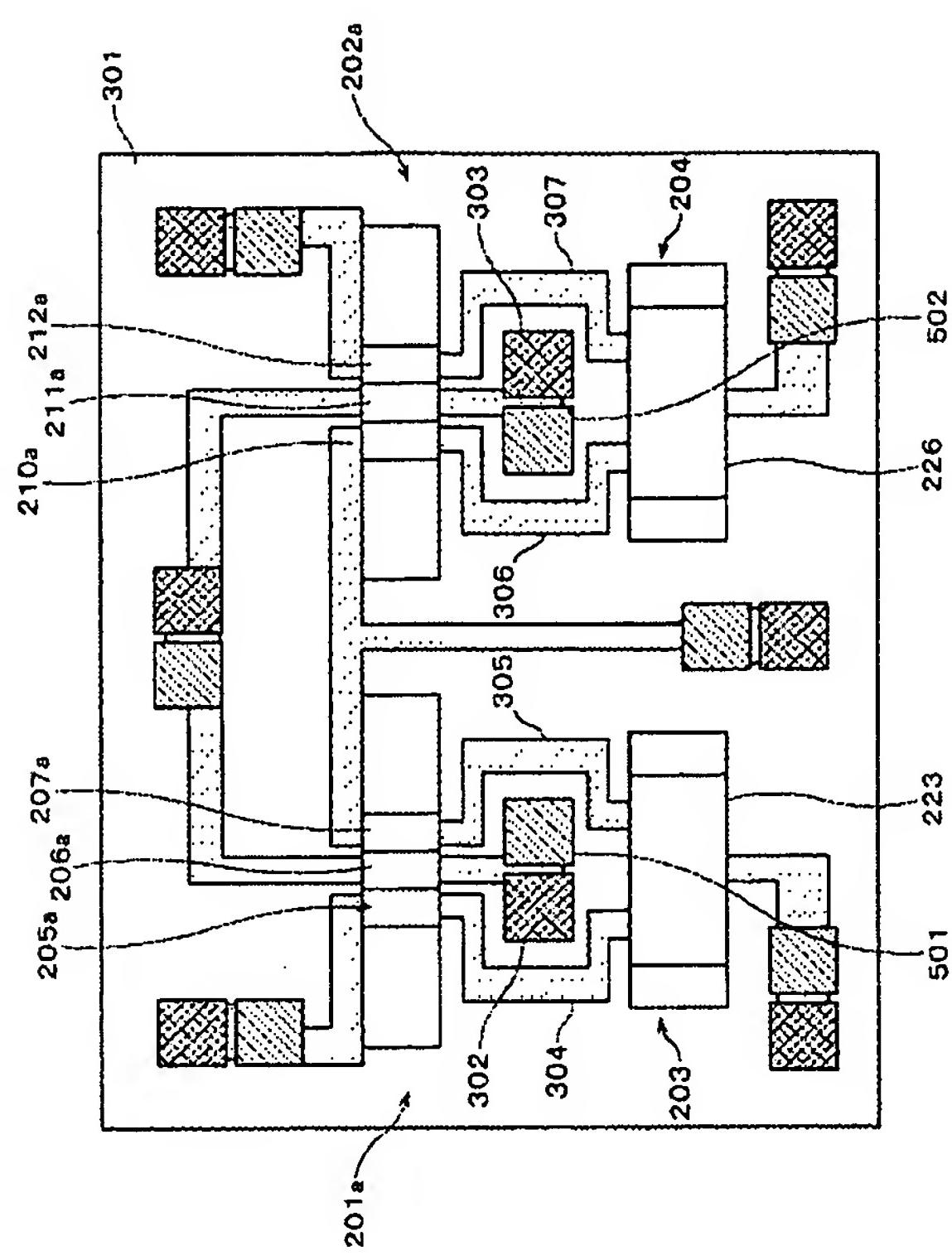
[Drawing 7]



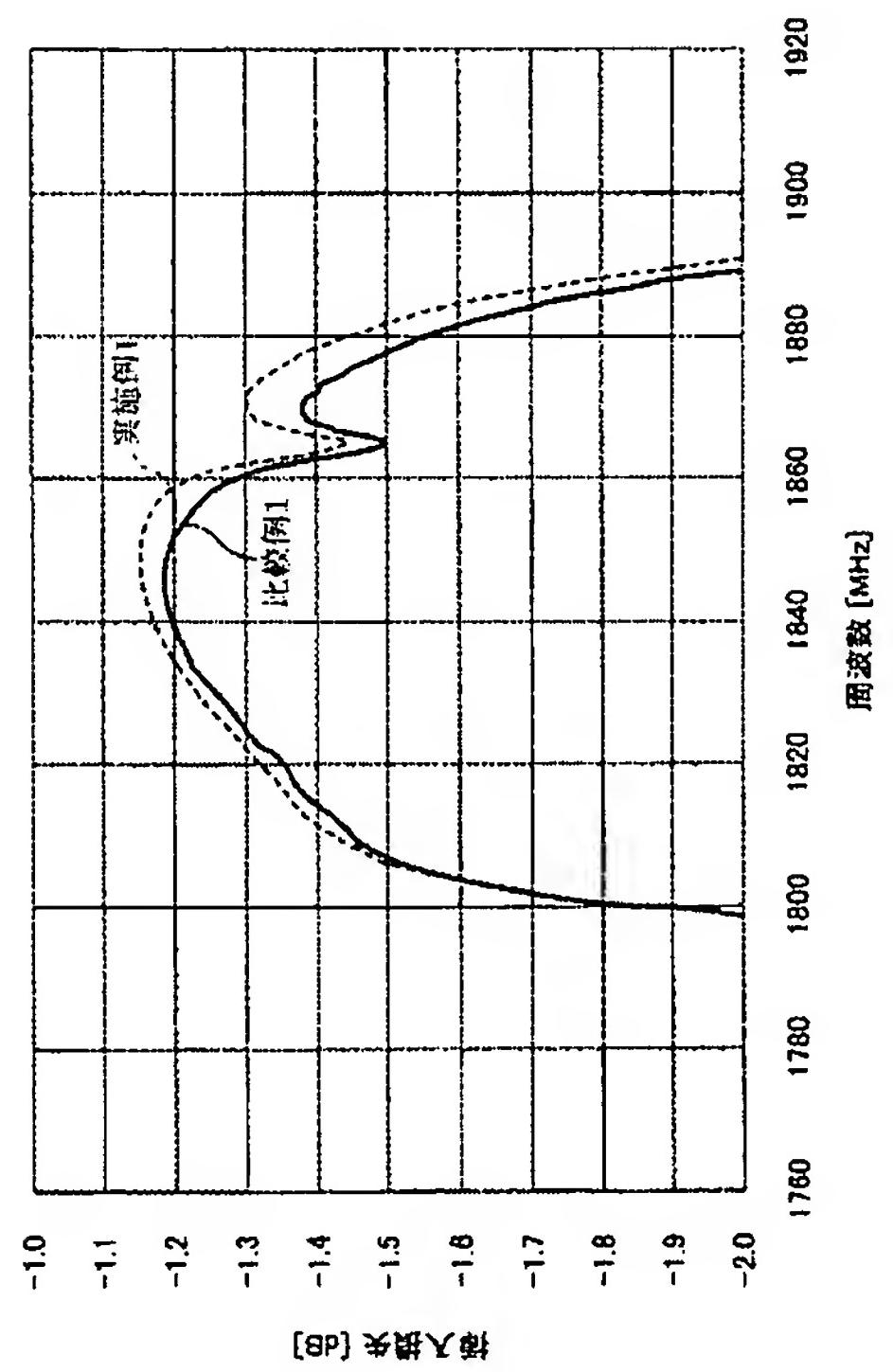
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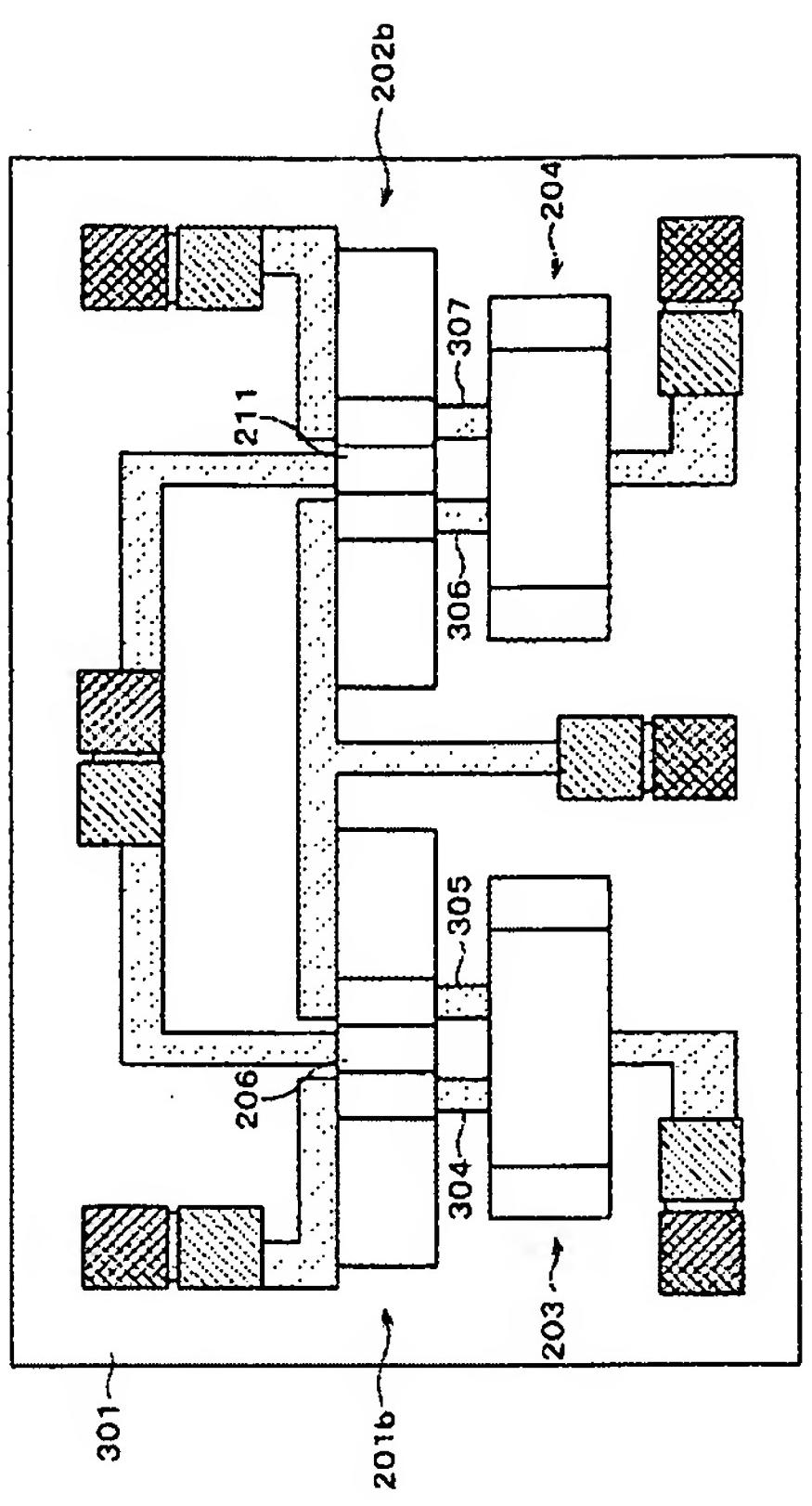
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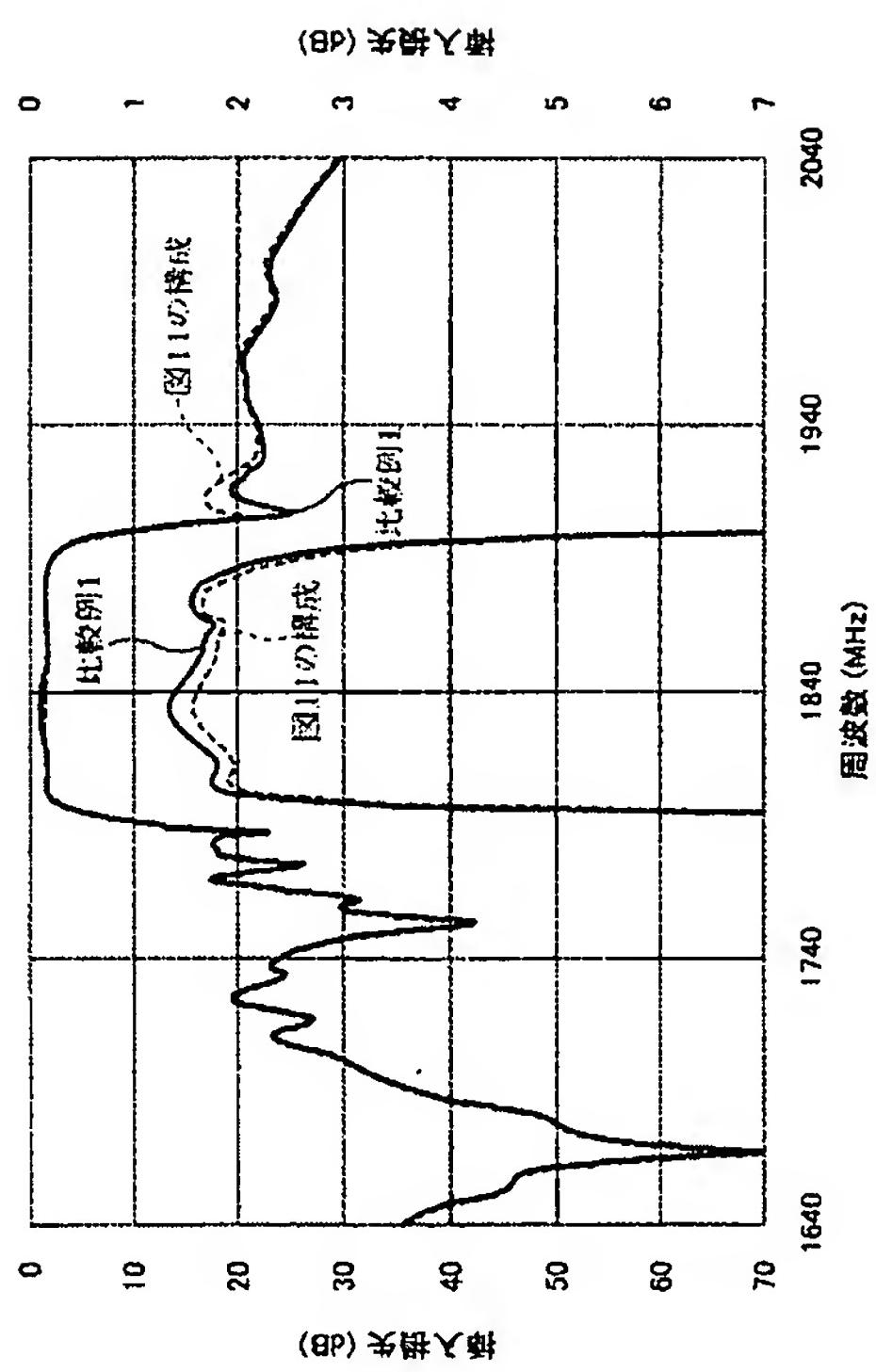
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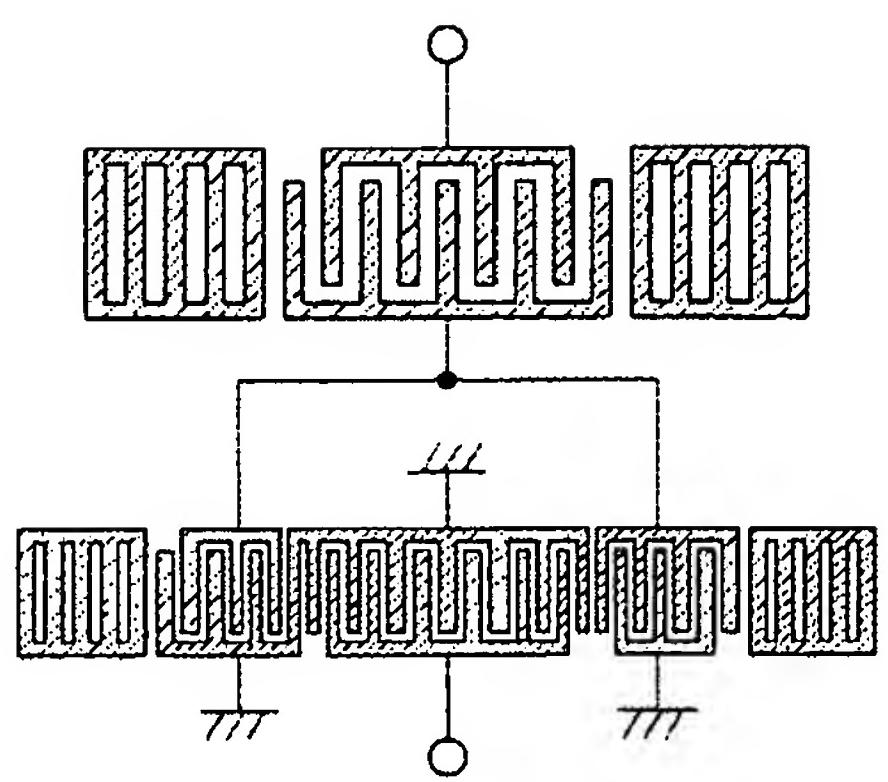
[Drawing 11]



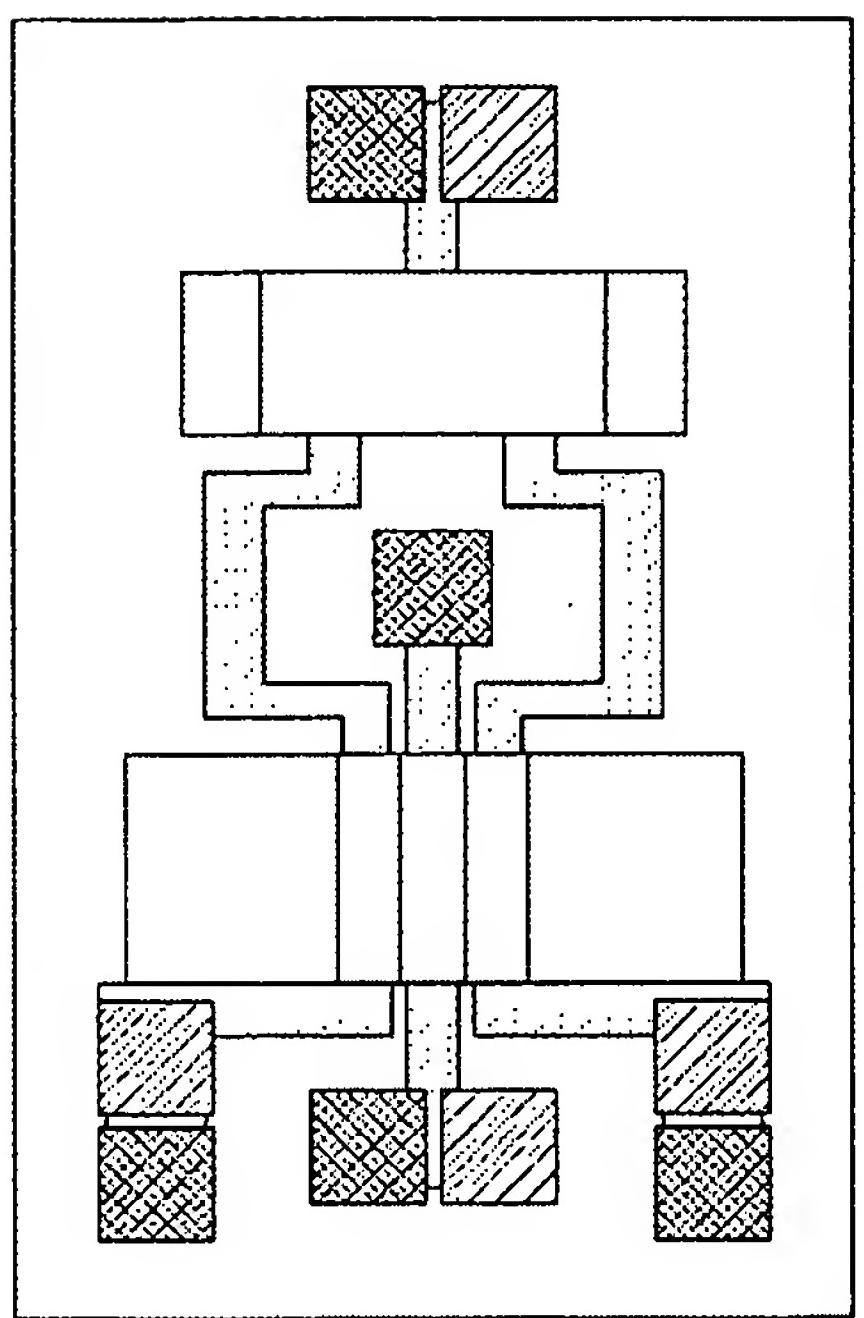
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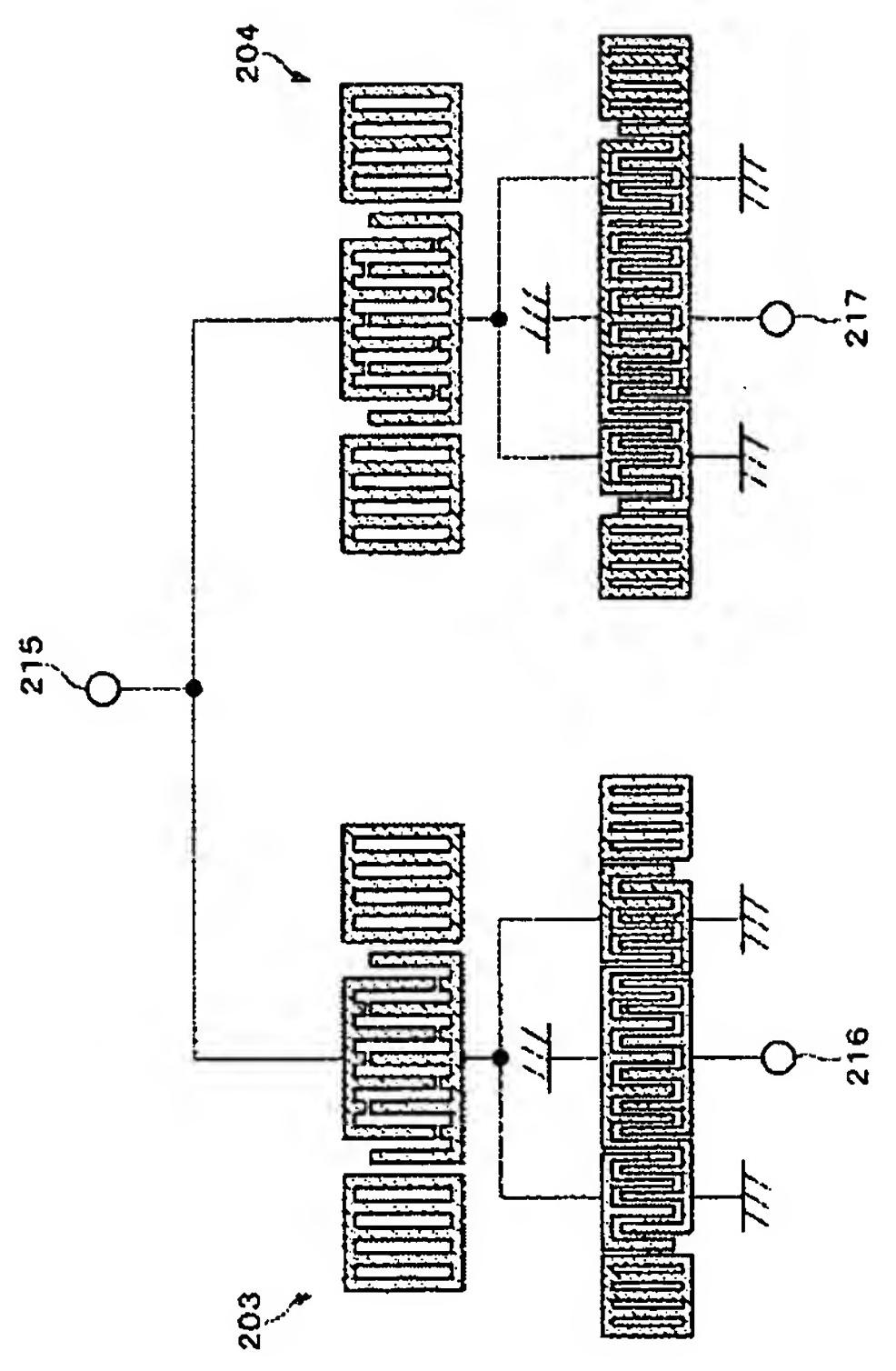
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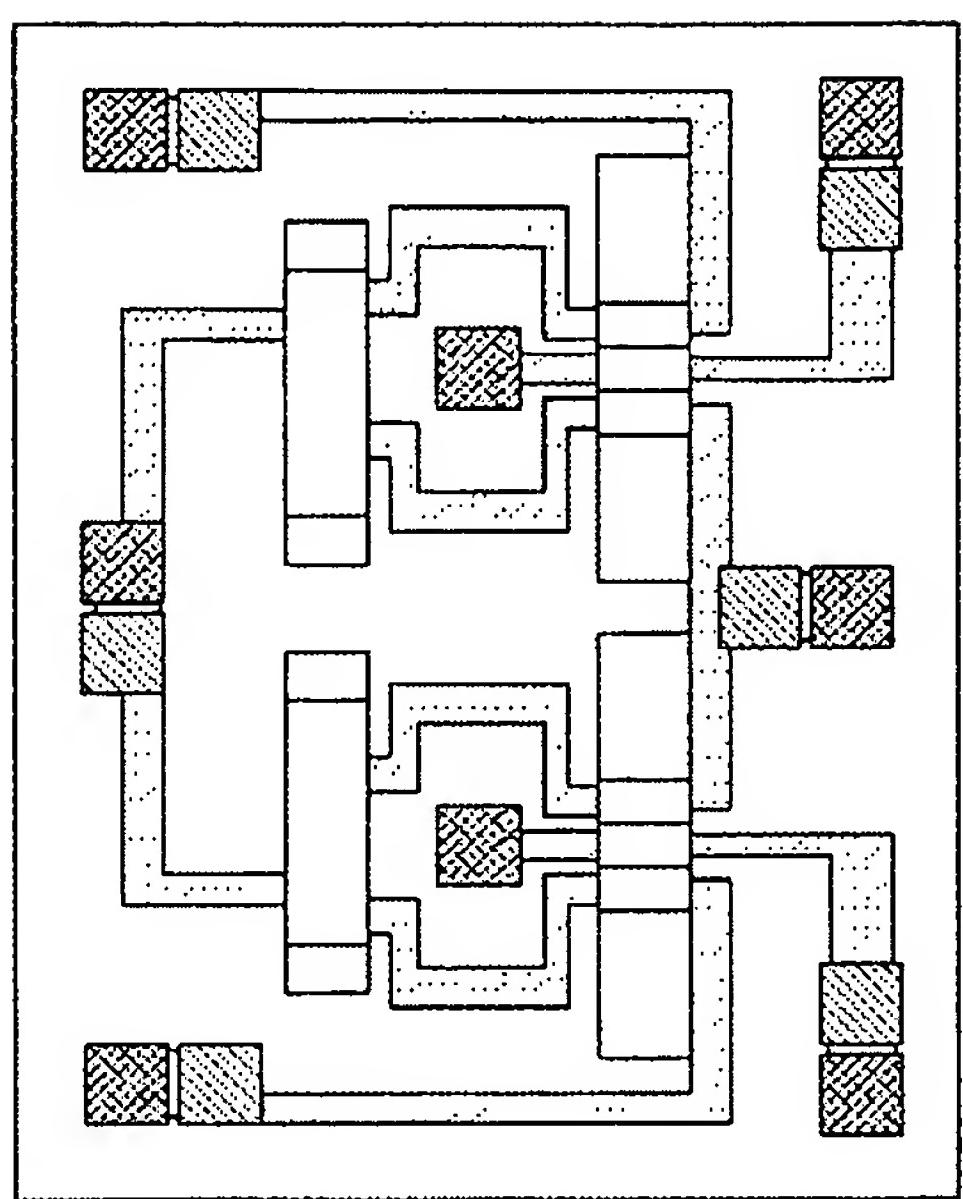
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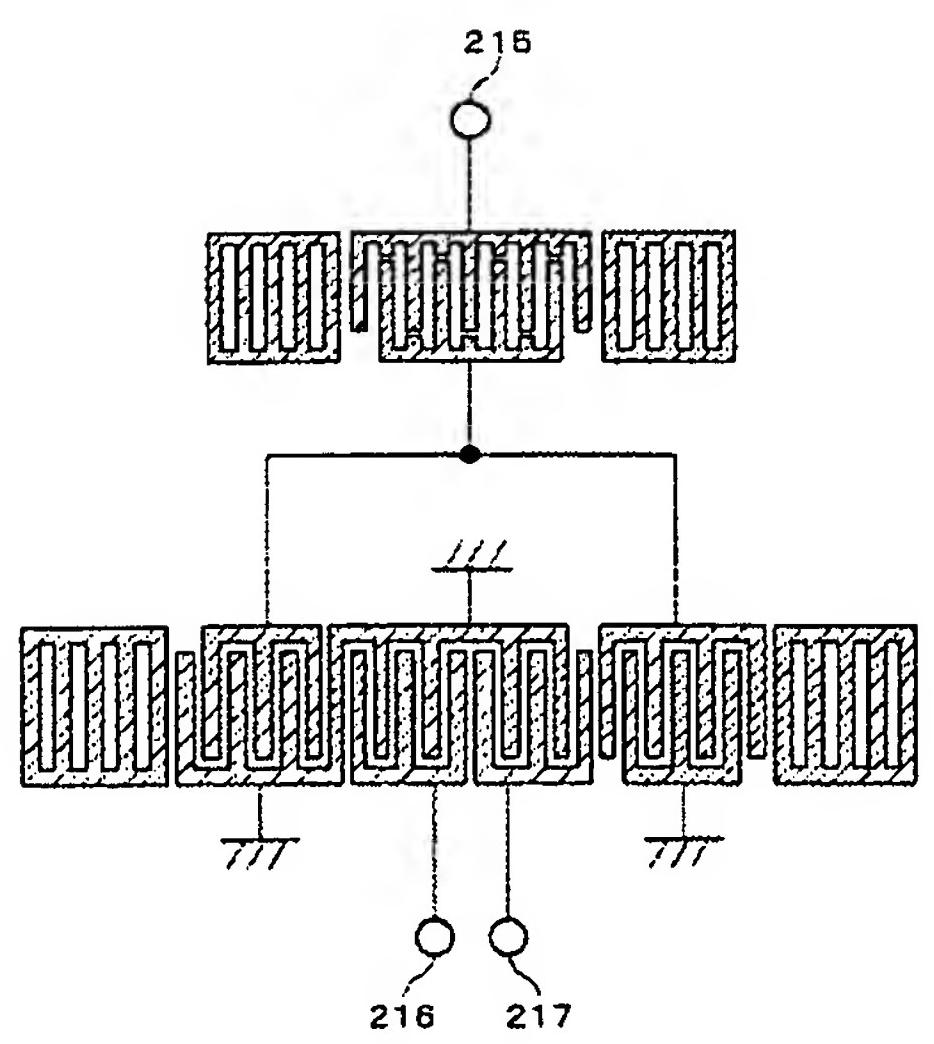
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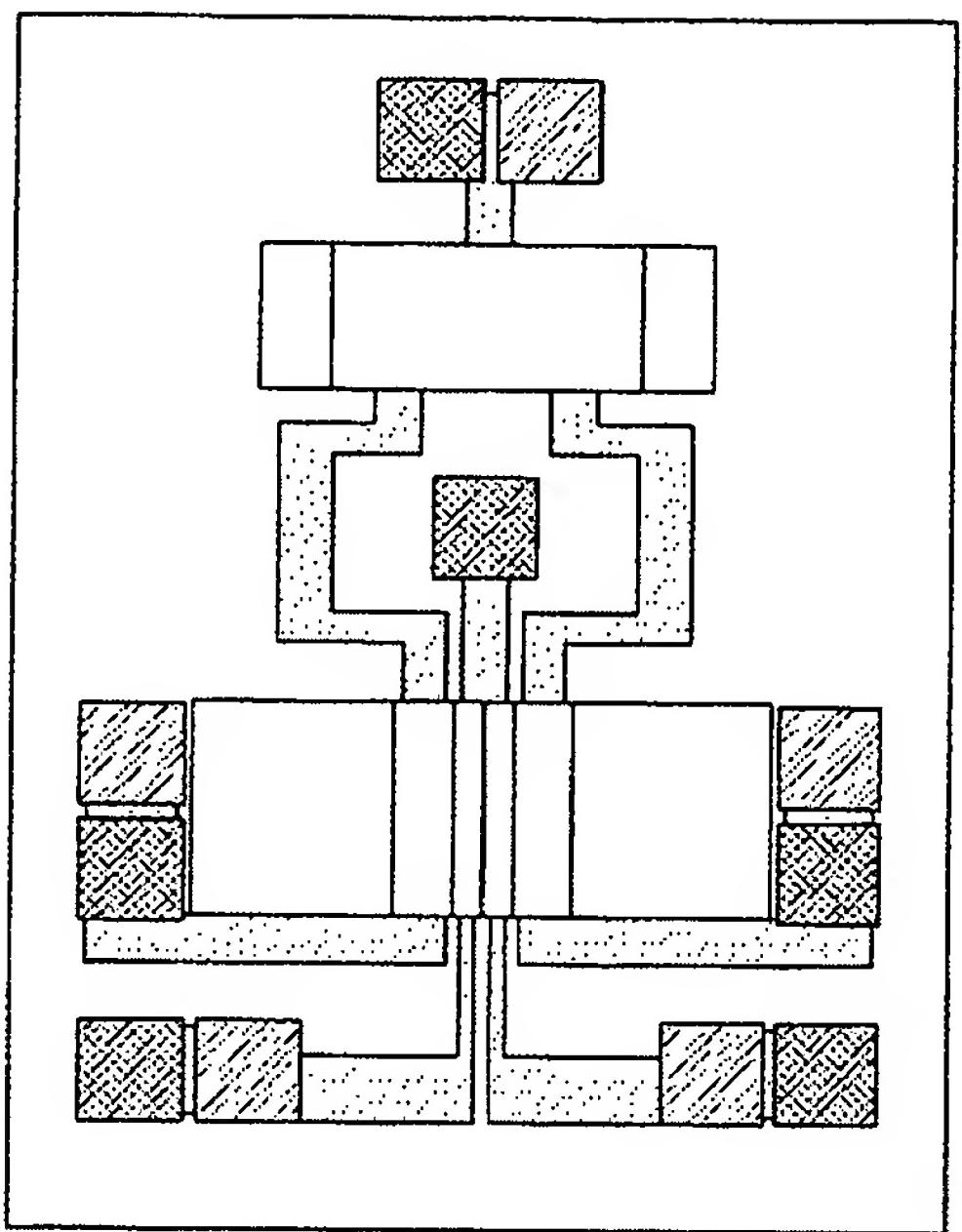
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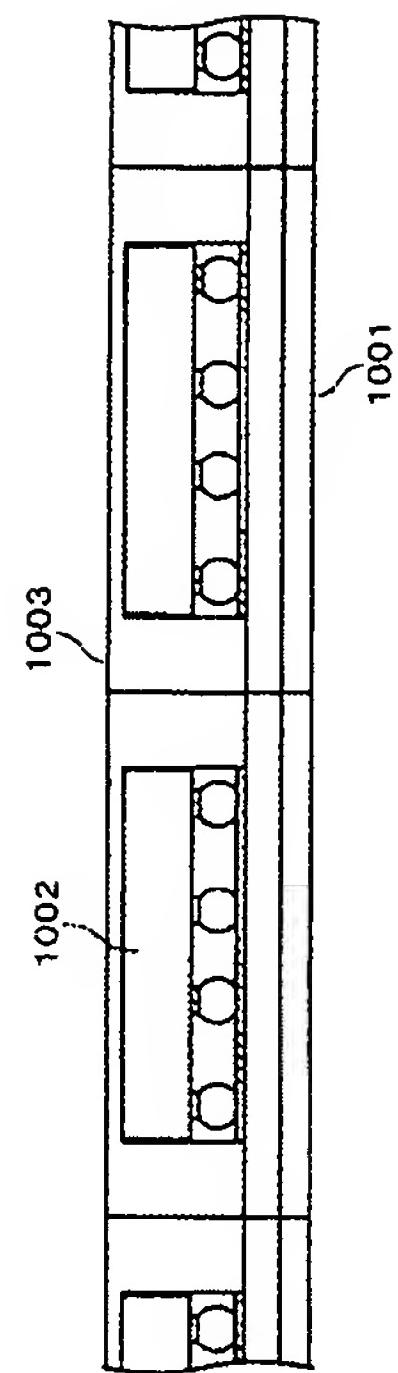
[Drawing 17]



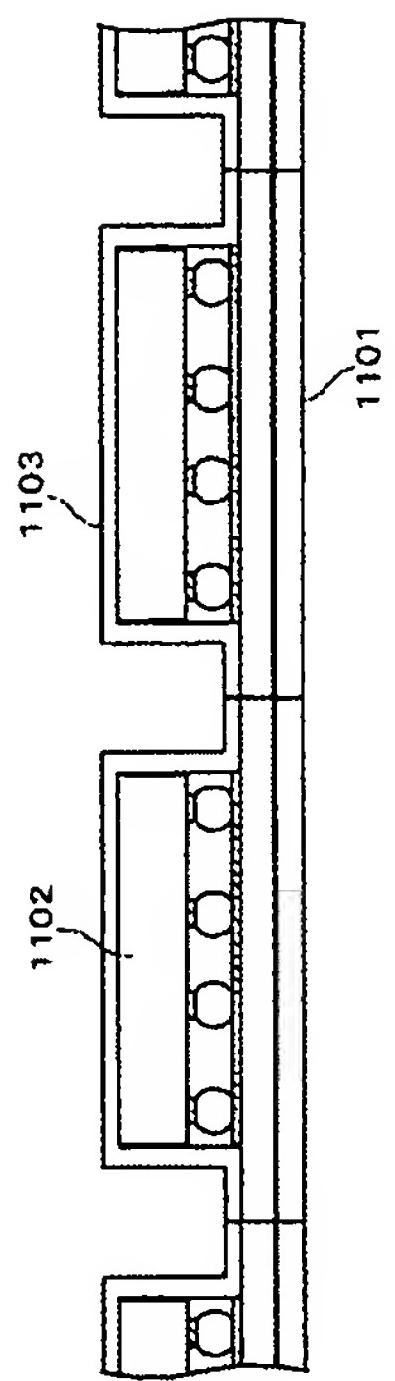
[Drawing 18]



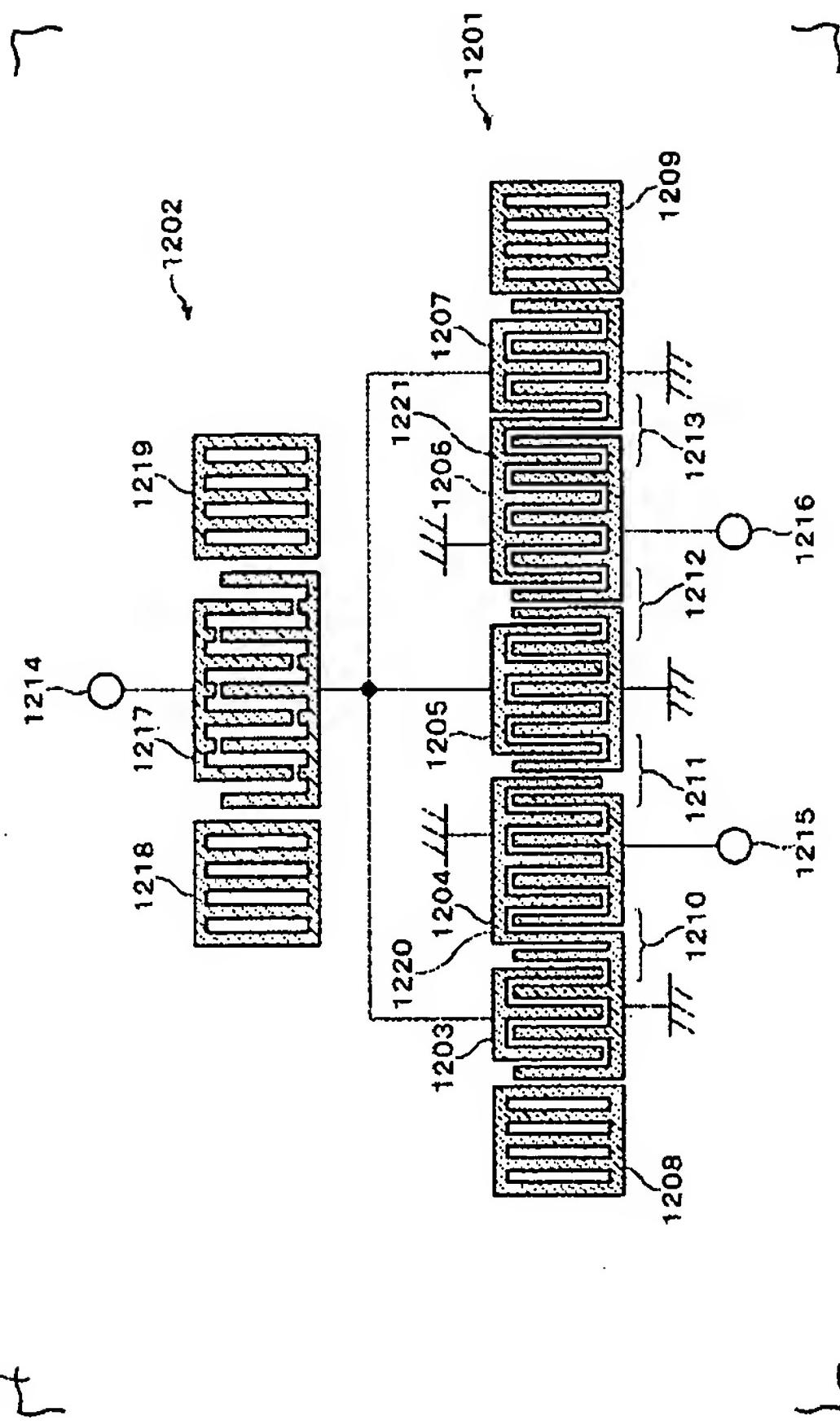
[Drawing 19]



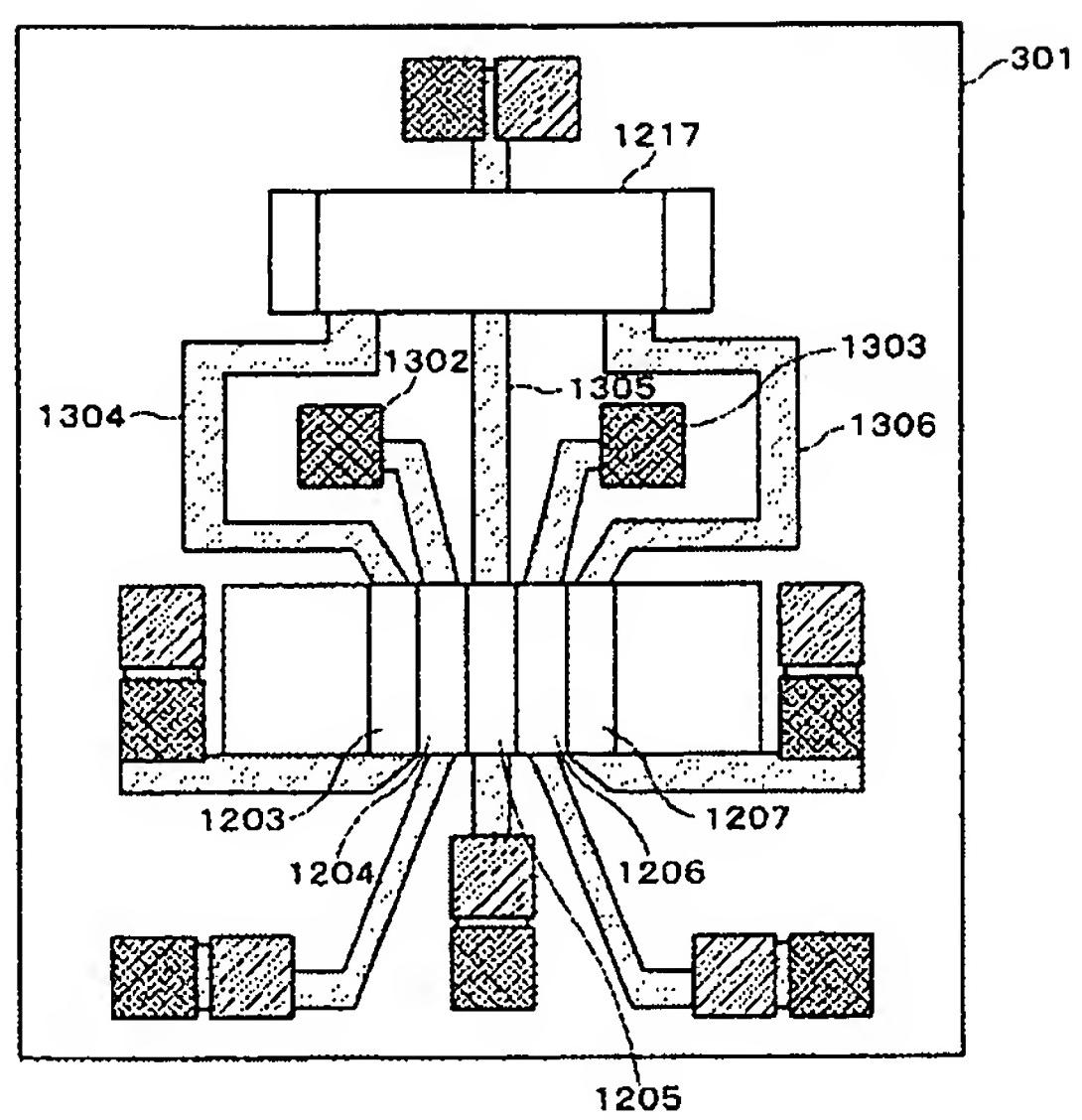
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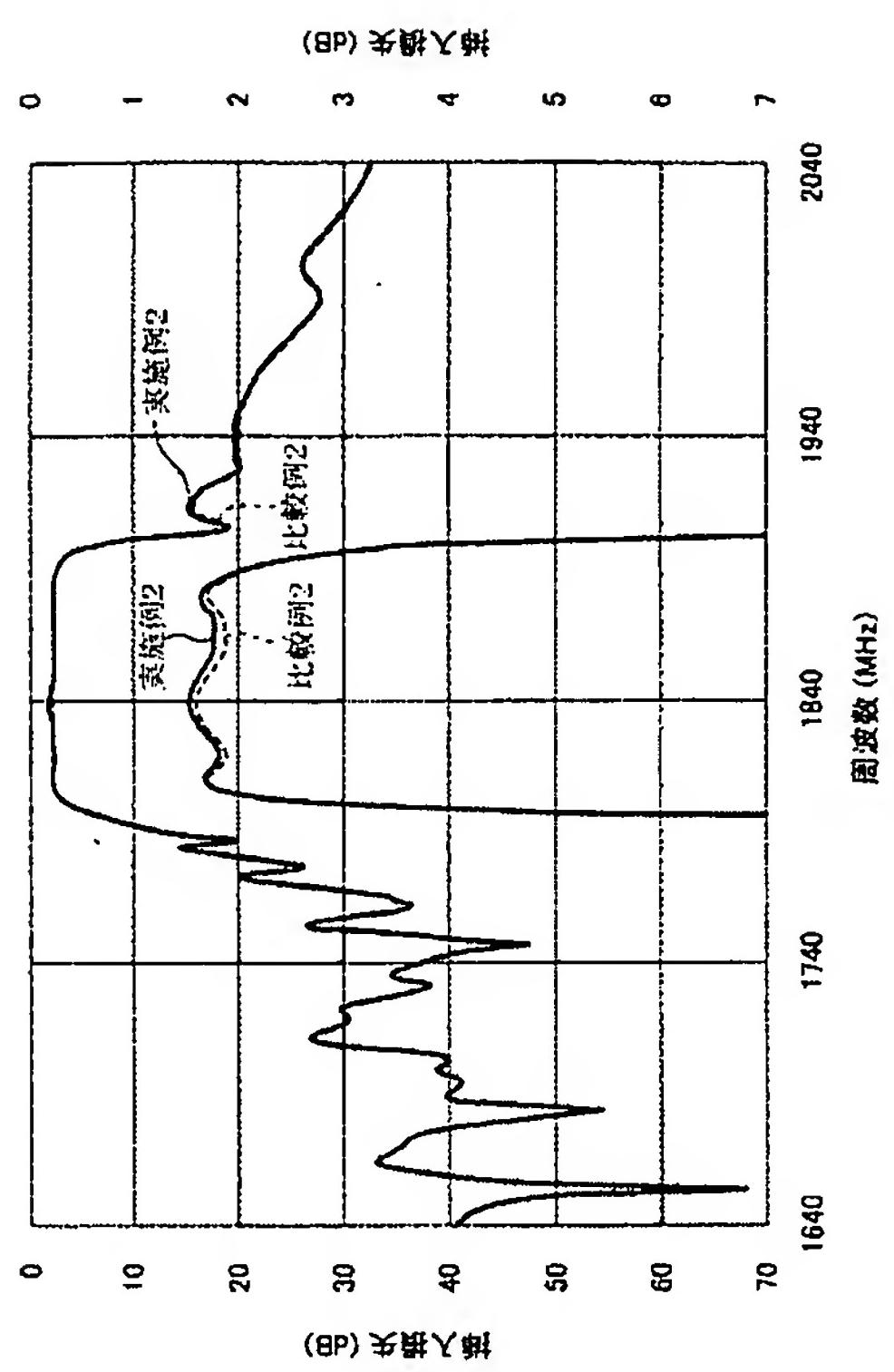
[Drawing 21]



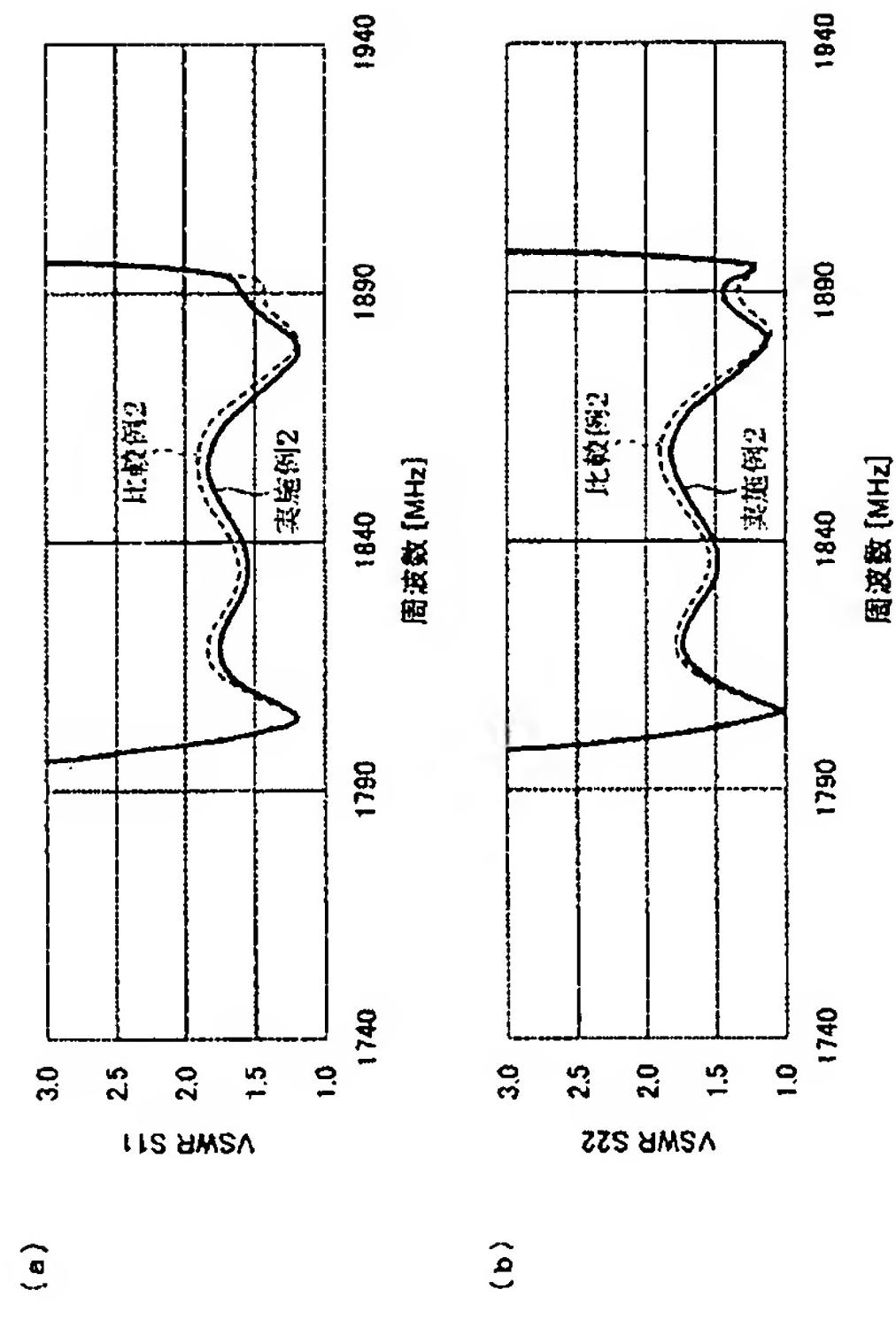
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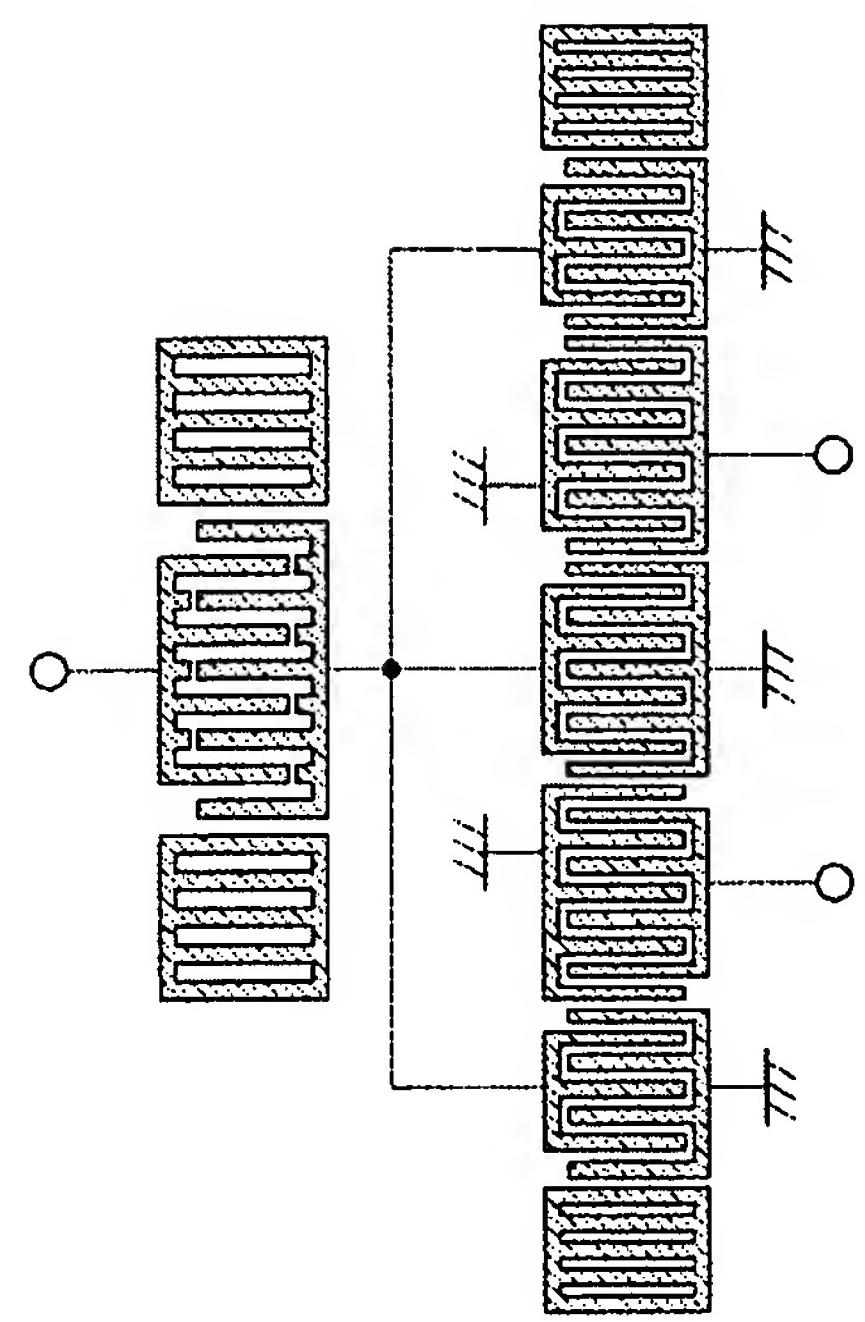
[Drawing 23]



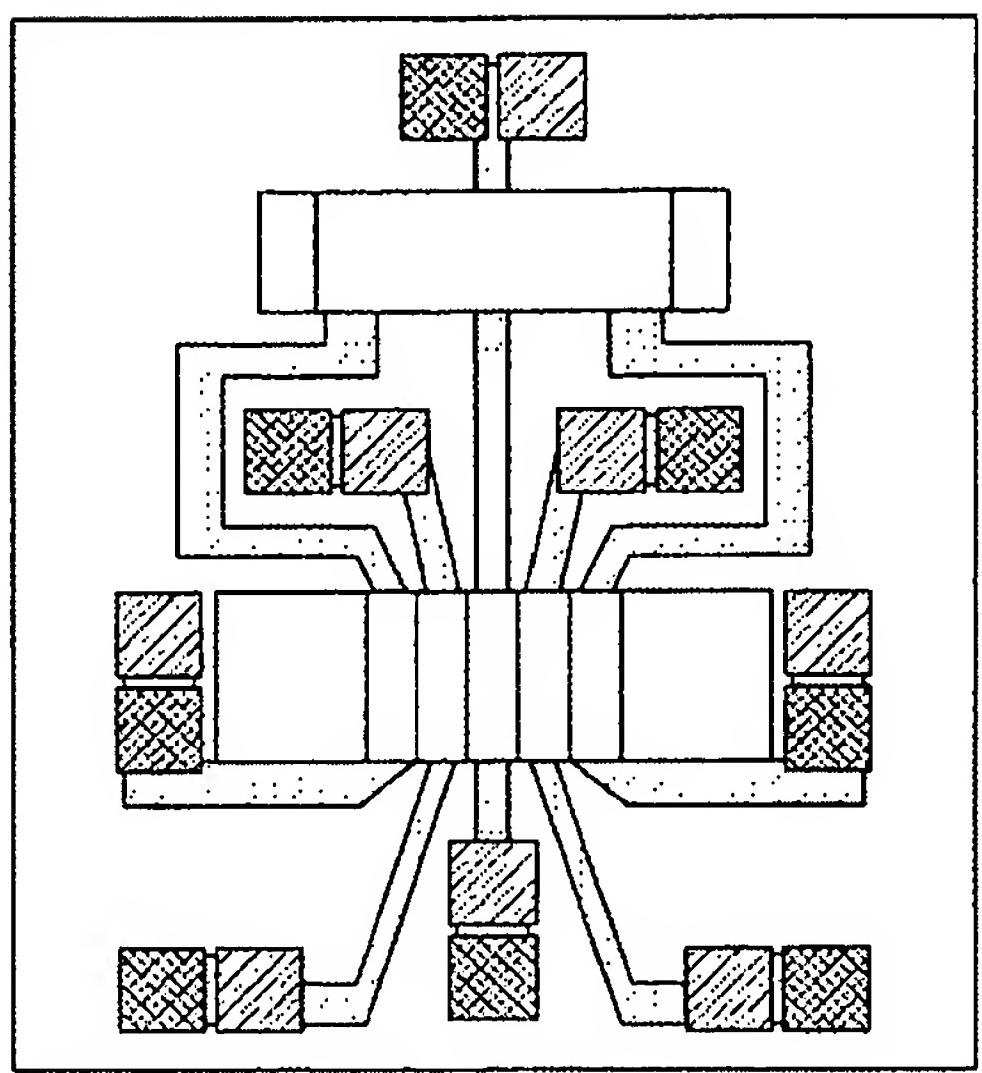
[Drawing 24]



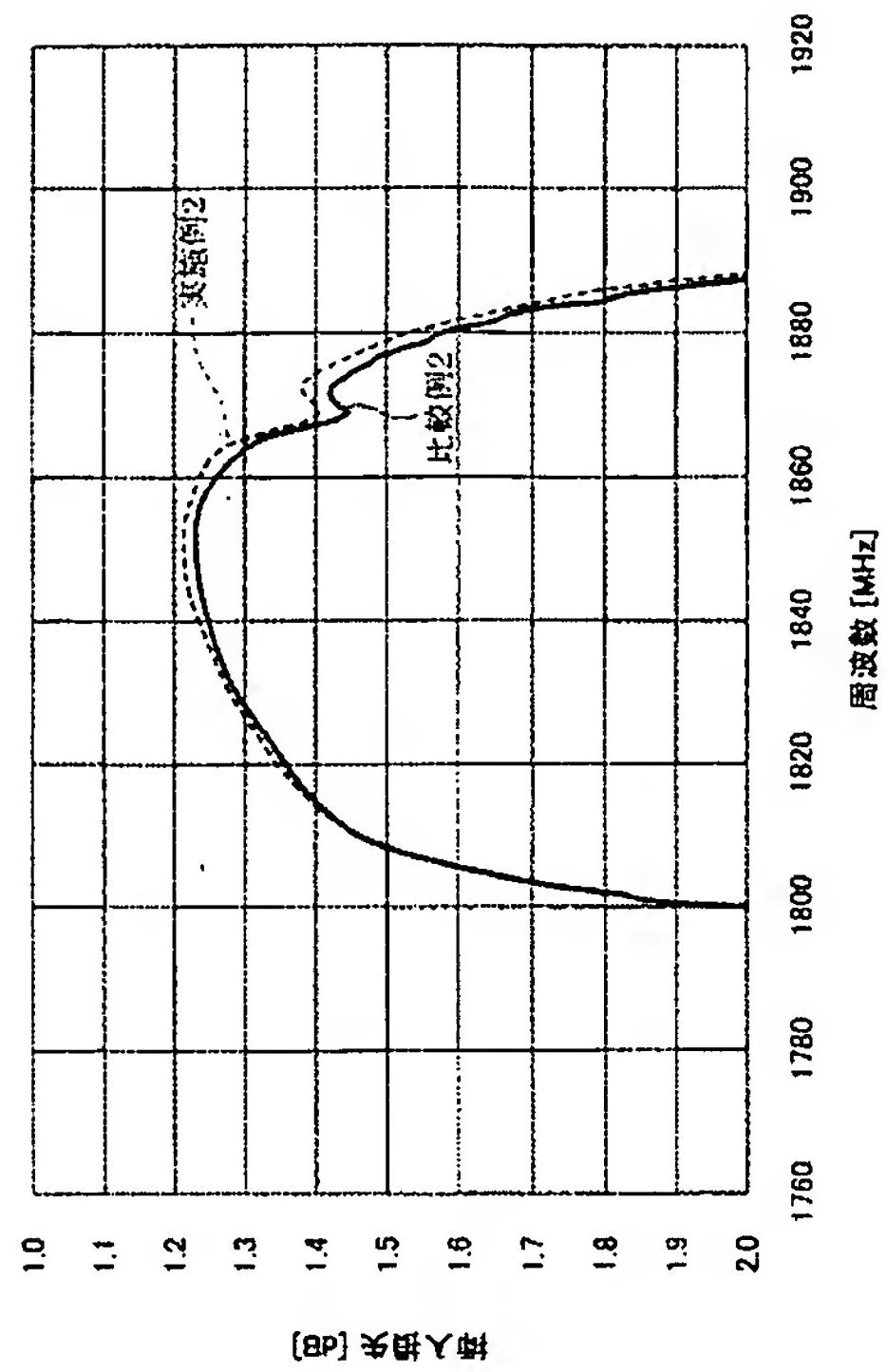
[Drawing 25]



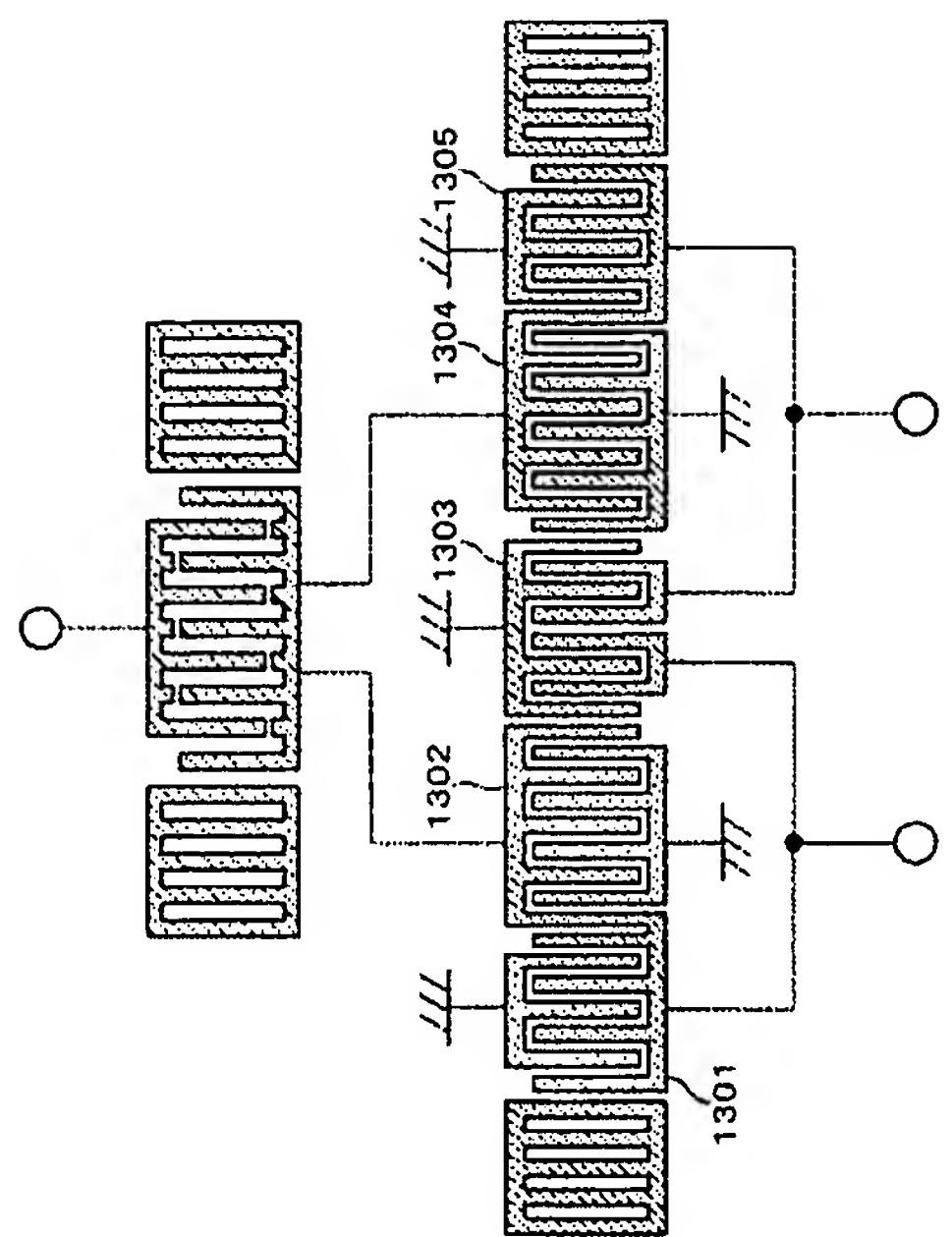
[Drawing 26]



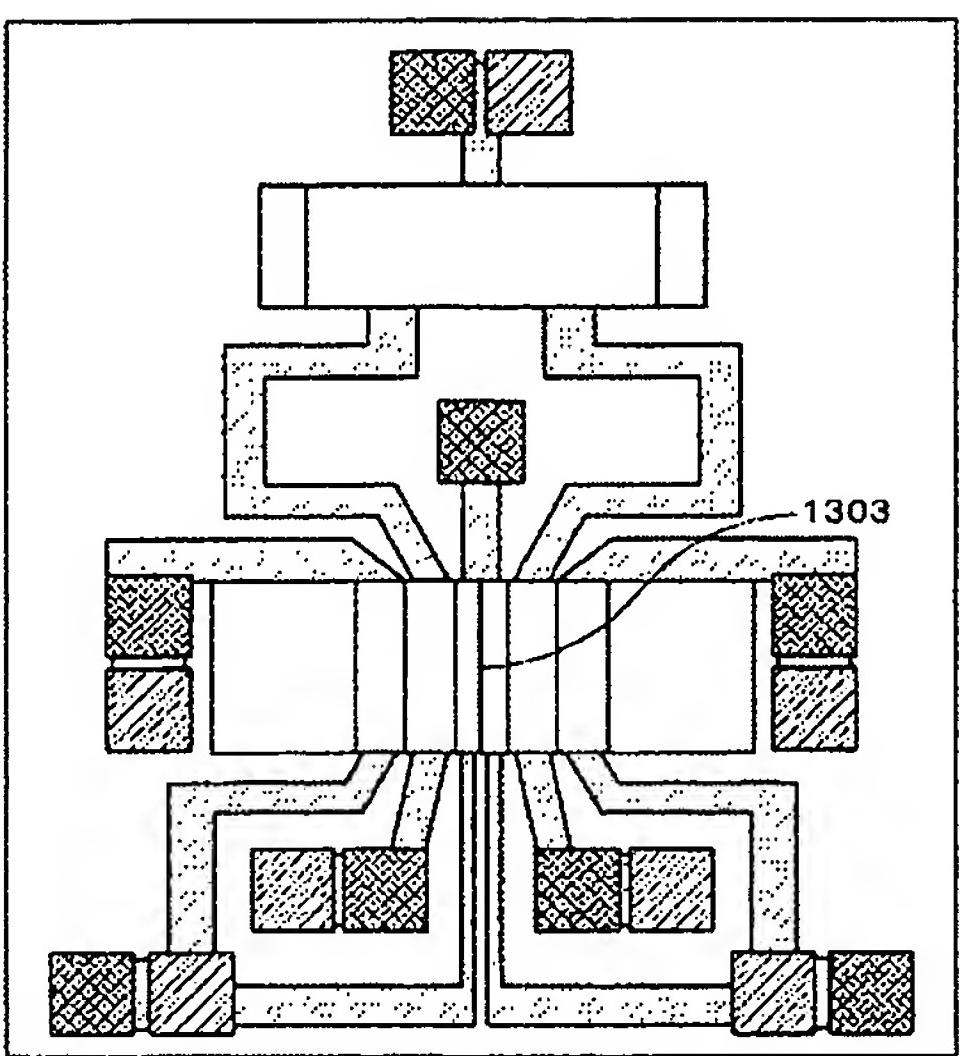
[Drawing 27]



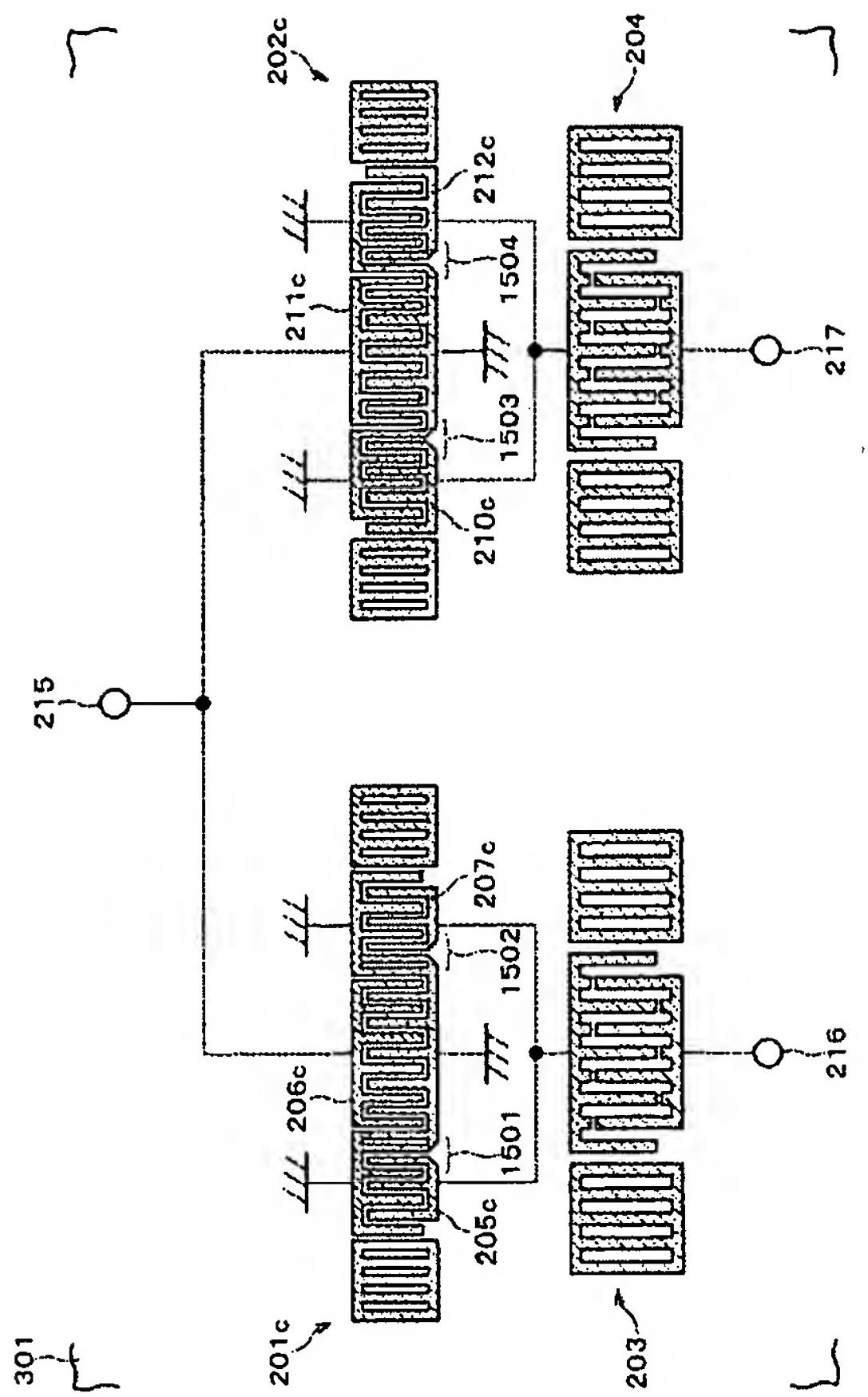
[Drawing 28]



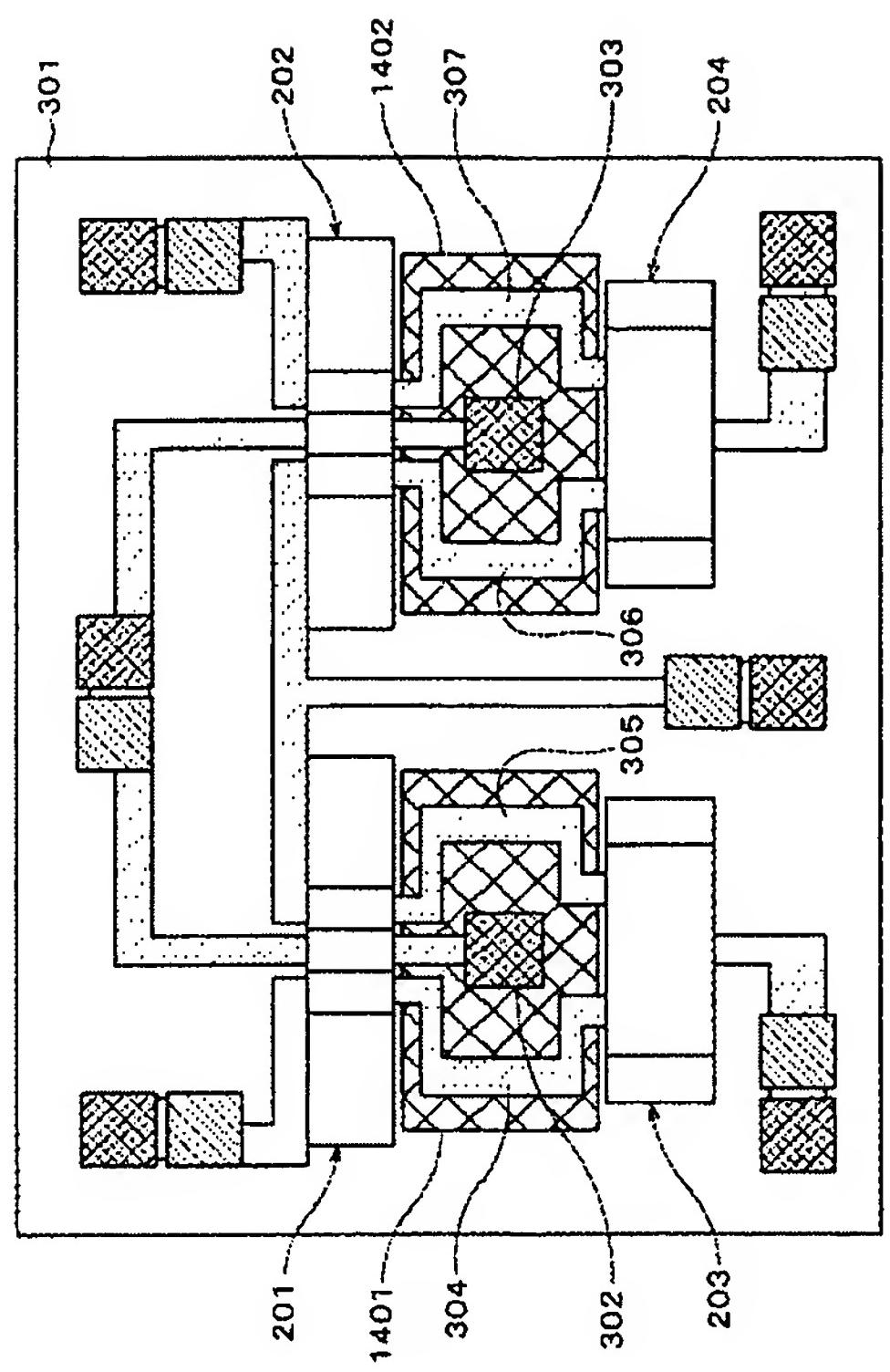
[Drawing 29]



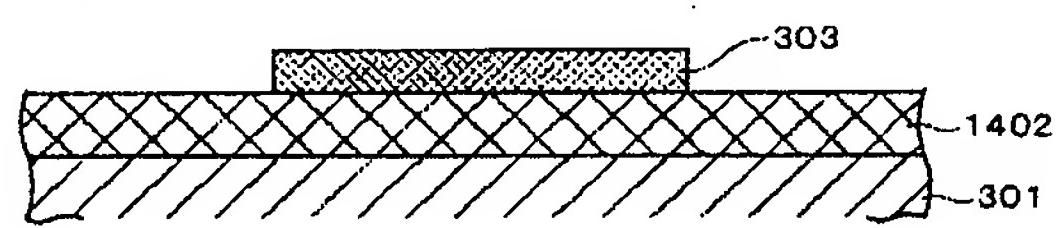
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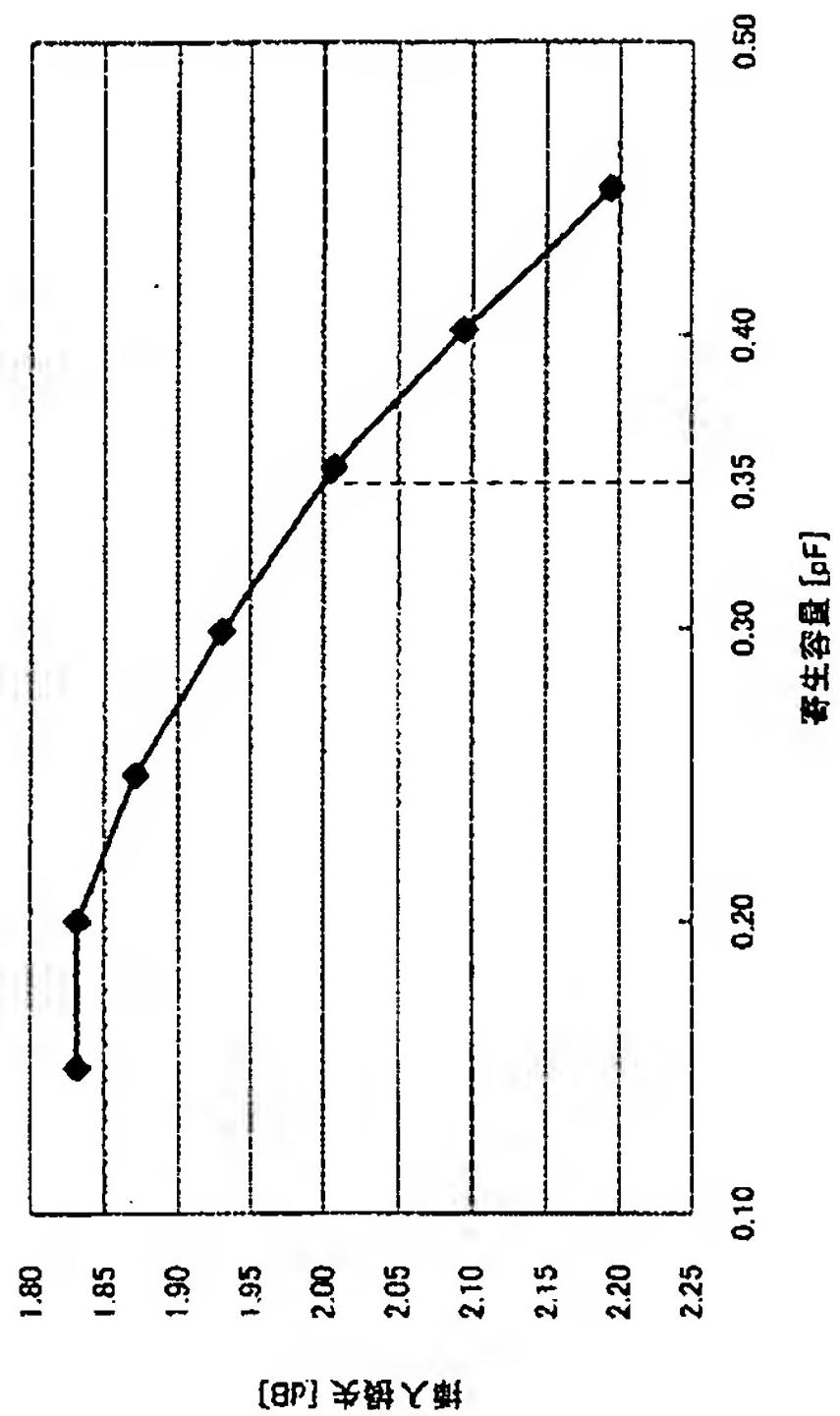
[Drawing 31]



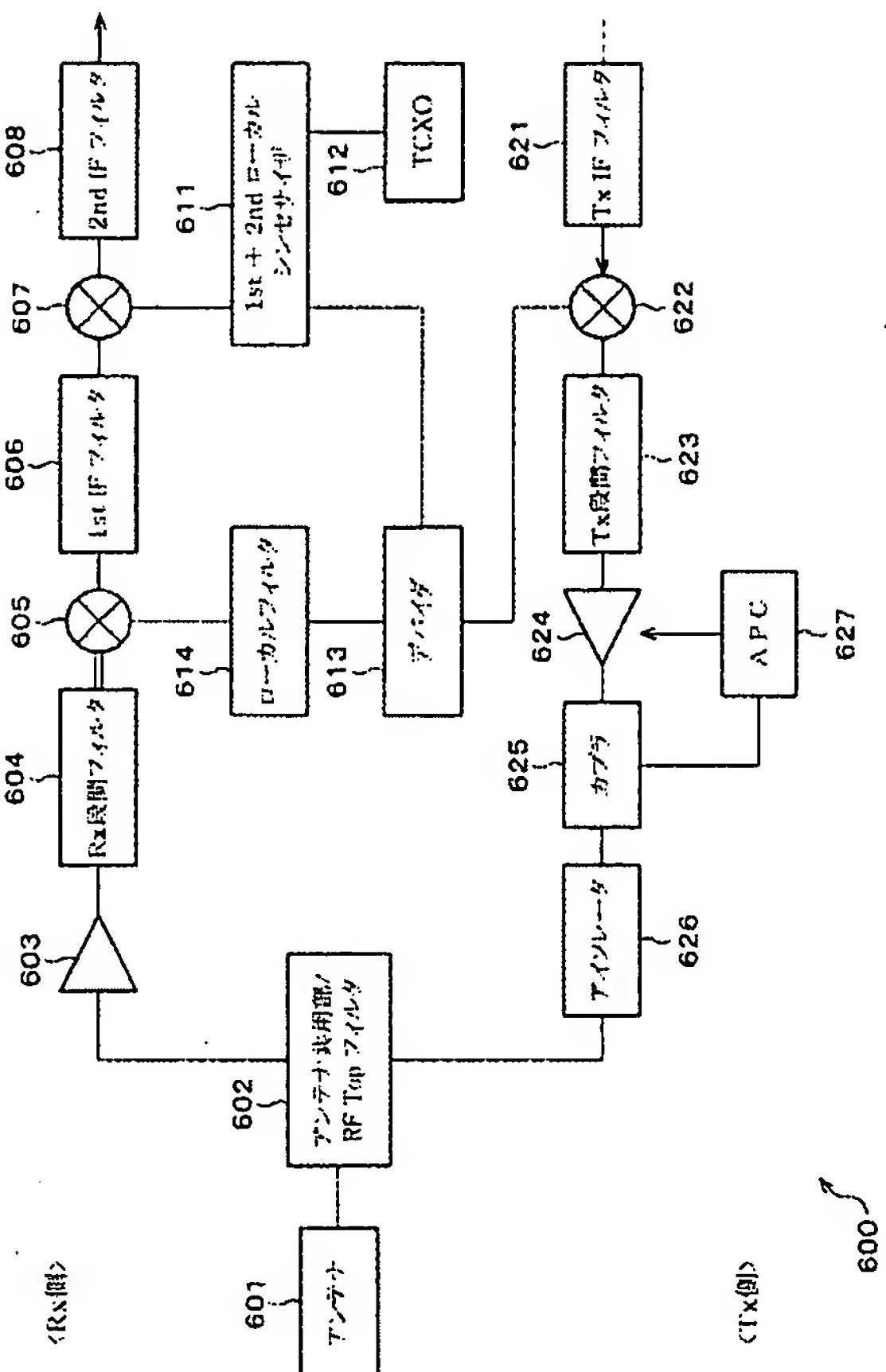
[Drawing 32]



[Drawing 33]



[Drawing 34]



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